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NOTES ON SAL PLANTATION IN THE GRASS-LAND AND IN THE KUKAT AREAS IN NOWGONG DIVISION OF UPPER ASSAM.

BY A. K. ADHIKARI, P.F.S.

Nowgong is the eastern limit of sal in Assam. Beyond this, in fact, natural sal does not occur in India. But the growth, it must be said, is not much inferior to Kamrup or Goalpara sal. The potential sal areas are divided into two classes—the grass-land and the *kukat*. The former is in the drier region and in areas unprotected from fire in the past. The latter are the fire-protected areas and often the moister region. The thatch areas have the associates more or less the same all over the district *viz.*, *Lagerstrœmia parviflora*, *Dillenia pentagyna*, *Zizyphus rugosa* and *Oenoplia*, *Wendlandia exserta*, *Randia* spp., *Hymenodictyon excelsum*, but the *kukat* areas have a variety of species of which the more evergreen types have generally taken possession of the moister areas wherever the fire-protection in the past had been rigid. The character varies according to the degree of protection they enjoyed.

Plantations have been started in both the above types and the method followed generally has been clear felling, burning, and sowing in lines, 8′ to 10′ apart, with *boga medeloa* (*Tephrosia candida*) sown midway between the lines. The results in the grassy areas are better. They are of course the type of land

where natural regeneration of sal is often noticed as opposed to *kukat* areas where the absence of regeneration is the marked feature. It is now definitely known that sal will not come under *kukat* and the spread of regeneration from the adjoining sal is, therefore, out of question, unless the *kukat* is converted into thatch by felling and burning. The only means of getting sal into these areas is, therefore, to grow them artificially.

Mr. Milroy has proved beyond doubt that natural regeneration of sal can be induced, obtained, and established by felling and burning, and perhaps it is the only system practicable in dealing with regeneration of large tracts of sal forests. But it does not do away with the fact that quite a lot of our reserve areas, whether covered with thatch or with *kukat*, will have to be regenerated artificially.

In the grassy reserves, such as we have in Hojai and in Lutumai, combination of both Mr. Milroy's method to enlarge the existing patches of sal and Bengal method to sow up the areas out of reach of seeds, seems to be the best means of tackling the problem. In grass-land instead of the lines being simply hoed, narrow trenches are dug. The trench, I must say, produces no appreciable results here on the growth of the seedlings, but its effect in killing grass out of the lines is marvellous. While filling in the trenches before sowing, we have now found out that if the sides are scraped and the earth is heaped in the centre—instead of simply filling the trenches to the level of the ground—a good deal of mortality due to damping or water-logging can be avoided, as in these parts of Assam, even the best porous soil of high well drained lands, unless noticeably sloped, after some time fail to soak up the excessively heavy downpour of monsoon. Besides this, the raised lines have another advantage. Generally after two or three weedings, the refuse piled up at the sides, tends to raise its level, with the result that the lines of actual sowing are slowly converted into shallow drains, but when the centre is raised this is avoided. The growth in the grass-land is pretty fast, perhaps faster than any I know. The *boga medeloa* keeps down the grass in the middle and by timely

pruning you can make the sal grow under the full overhead light and at the same time reduce the cost of weeding. *Boga medeloa* as fertiliser may help the growth to some extent, but so far as we are concerned its value lies in its mechanical utility as suppressor of weeds. It should also be remembered that if grass is completely ousted *Eupatorium* will come in. Sal seedlings can grow pretty well through the grass, but once there is *Eupatorium* it will add enormously to the cost of weeding. It has been possible to strike a balance by the timely and judicious pruning of *boga medeloa.* In the grassy areas, generally two weedings, one really freeing the seedlings within a month of the germination, and the other by the end of August will be sufficient, whereas in the *kukat* areas at least three weedings are necessary. When the seedlings are about $2\frac{1}{2}$ years old they measure about $6'$ to $7'$ high and are big enough to look after themselves, whereas in the *kukat* areas, at this age, seedlings are no more than $3'$ high on an average. There is a complete absence of ground creepers in the grass-land plantations—effect of past burning—whereas in the *kukat* areas they are the greatest menace—result of fire-protection of the past.

It may be said, why not convert the *kukat* areas into thatch and then either wait for the neighbouring sal to extend or sow up artificially, but it should be remembered that bringing in thatch is not so easy. It takes time. It costs money. The cutting back for the first two or three years and burning year after year are all difficult tasks. Again natural regeneration by the process of felling and burning is slow and extending is slower still. The other alternative is to grow the seedlings artificially and look after them for the first season and then burn them along with the weeds annually, knowing that the weeds will be converted into grass and seedlings will come out stronger with the burning. An experiment combining the Bengal and Mr. Milroy's method, such as suggested above, is worth trying. Another thing that may be tried is to ascertain whether a receptive condition in the soil cannot be induced by preliminary burning for a few years by cutting the undergrowth and thinning out the canopy, that is to say, whether the progress of thatch could not

be enhanced and the invasion of weeds reduced and survival of seedlings assured by this process instead of opening out the canopy suddenly.

Measurement of height growth of sal in Hojai (Nowgong, Assam):—

Sown in June 1928	...	...	average 5′
" " June 1929	...	...	" $2\frac{1}{2}$′
" " June 1930	...	...	" 6″

TEAK IN THE UNITED PROVINCES.

By F. Canning, I.F.S.

It has been suggested to me that the article by the Conservator of Forests, Working Plan and Research Circle, United Provinces, on the above subject, which appeared in the September issue of the *Indian Forester*, may give a somewhat misleading impression of our policy.

Briefly the position is that a comparatively small area of old teak plantation in Gorakhpur was successful. Felled at the age of about 45 years it sold well. But conditions in Gorakhpur are in many respects different from those elsewhere in the province and the sale of one individual small area is insufficient as a basis for a forecast of the financial possibilities of teak in a province where sal timber provides half the total Forest revenue.

Beyond the above our experience lies practically entirely in the propagation of crops which are still quite young. Thanks to the excellent work put in by many officers, rangers and other ranks, we have attained considerable success in the initial establishment of young crops of teak in many places. But there is no intention whatever of replacing sal by teak. In sal forests it is only introduced, where sal regeneration has not been obtained. The main problem of our research work is still to ascertain how to obtain sal regeneration in all the varying conditions, where at present difficulty is experienced. Teak has proved the easiest species to introduce in blanks in many of our sal forests and is consequently the species most extensively used in this way. But its future is viewed by many with doubt. The young growth is

as yet not sufficiently far advanced to say whether it will grow well to maturity. The ease with which it can be introduced artificially has led naturally to its trial in places, where conditions are not eminently suitable and the general tendency at present is to limit rather than extend its introduction in sal forests.

EROSION IN THE PUNJAB HIMALAYA AND ITS PROBABLE EFFECT ON WATER SUPPLIES.

By L. B. Holland and H. M. Glover, I.F.S.

The subject of erosion consequent on the disappearance of forests in the outer Himalaya is engaging the attention of the Punjab Government, and it is thought that you may be interested to learn the views of Forest Officers on this very important subject.

Two technical papers have recently been published, 'Denudation of the Punjab Hills,' by B. O. Coventry, I.F.S., Indian Forest Records, 1929, and 'A Report on Denudation and Erosion in the Low Hills of the Punjab,' by L. B. Holland, I.F.S., 1928: the latter as the result of a special enquiry in 1927-28. In this paper the general aspect and extent of erosion and its probable effects on water supplies will be discussed, and in order that the problem may be easily understood some description will first be given of the geographical, climatic, geological and other factors.

The Punjab consists of low lying alluvial lands in front of the Himalaya, and these lands are now irrigated by a magnificent system of canals dependent for their water supplies on the rivers which debouch from the Himalaya. The catchments of these rivers, with the partial exception of the Indus and Sutlej which rise in Tibet, lie either in British territory or in States under the political control either of the Government of India or the Punjab Government.

The rivers are tapped by canals where they enter the plains and again lower down where drainage from the country below the head works has caused an appreciable amount of water to collect in the old river channels. The rivers all show more or less the same periodic variations in supply. The winter is a season of low water and all is used for irrigation: in the spring the water rises with the melting snow; and in the monsoon the rivers are in full flood and are uncontrollable and the greater portion of the water escapes to the sea and is lost to the Province.

RAINFALL.

The rainfall is profoundly affected by the summer monsoon. During July, August and September the moisture laden winds from the Arabian Sea and from the Bay of Bengal strike the barrier formed by the Himalaya and the clouds drop the greater part of their water contents, and as they pass in succession over the inner ridges more and more water is dropped until the great Himalayan range is reached where the last rain is precipitated. Beyond this barrier very little rain falls and the country is dry and sterile. In the spring and autumn little rain falls for weeks on end. In the winter snow falls in the inner hills and accumulates to depths of several feet. In Tibet there is no rain during the spring, summer and autumn and in the winter snowfall is less than in the inner hills. Some figures may be quoted:—

Dharmsala on the slopes of the Dhaula Dhar has a rainfall of over 100 inches: Dalhousie 85 inches: Simla 63 inches: Kotgarh 50 miles beyond Simla 45 inches: Kilba 120 miles beyond Simla 31 inches: Purbani 140 miles from Simla 30 inches, of which 19 inches is due to winter snow: Poo 200 miles by road

from Simla has a rainfall of only 14 inches. Rainfall varies with elevation, and whereas the tops of the hills are often moist the valleys are dry and sterile. In the inner Himalaya the streams are glacier fed and towards the Tibetan border winter snow and glaciers form the sole sources of supply of water to the streams.

GEOLOGY.

A sketch of the geological features must of necessity be brief and only a short general account is given in order to render this paper intelligible. The main mass of the Himalaya consists of granite and crystalline rocks. Spiti contains thick beds of fossiliferous limestone and sedimentary strata: the inner Himalaya consists of crystalline rocks and metamorphosed sedimentary strata twisted and contorted till all traces of their organic contents have been lost. All these formations are more or less stable and the hard rocks are not liable to displacement. The mountain ranges of the Himalaya were formed by the effects of pressure from the north which caused their upheaval when confronted with the buttress formed by Hindustan. In front of the rising Himalaya were deposited in shallow sea conditions the Tertiary sandstones and clays which in their turn took part in the general uplift and were folded and bent and now occupy the zone of the outer hills from Sabatu to Hazara. In front of and on these strata were deposited detritus and the Siwaliks form a range in front of the Himalaya consisting of soft friable sandstones and pebble beds which in their turn have been folded and elevated. The plains consist of vast alluvial sediments deposited in front of the Himalaya.

EFFECT OF FOREST ON RAINFALL.

The rainfall is affected by the geographical position of the locality and is due to causes on which forests have little effect. It is thought that forests increase local precipitation but the evidence therefor is somewhat vague and indeterminate.

EFFECT OF FOREST ON RUN OFF.

A forest consists of trees or scrub and below the trees is a mass of young growth, bushes, herbage or grass and humus

growing on a deep porous soil into which rain water percolates and enters cracks and fissures in the underlying rocks, emerging eventually in the form of springs, many of which are permanent. Only when the surface soil is supersaturated does the water run over the surface. Thus rain which falls during the summer monsoon emerges some weeks or months later from springs and replenishes the autumn and winter supplies of the rivers. The soil is retained *in situ*: the water in forest streams is clear and does not contain much sediment in suspension. Far different is the effect of rainfall on barren slopes. The soil is thin and hard, and rain when it falls runs over the surface soil and enters the streams during the monsoon.

As forests disappear more and more water enters the streams which constantly broaden their channels which are insufficient to carry the largely increased supplies. Floods occur which increase rapidly in intensity, and when rain storms synchronise in neighbouring catchment areas sudden and high floods are caused in the rivers, which in their turn are incapable of retaining their water in their channels and floods spread over the adjacent country side. We all remember the disastrous effects of the floods of September 1924 in the Jumna and Sutlej rivers; of August 1928 in the Chenab and Jhelum rivers and the floods of 1929 in the Jhelum and Indus rivers to quote only very recent history.

It appears that floods are greater now than formally, and now that the waters of the Punjab are being utilised to their full capacity, are likely to be greater in their economic effects. We may take it as axiomatic that the intensity of floods is rendered greater by the disappearance of forests and it is of interest to examine the sources of supply of the rivers and the condition of forest growth and soil covering in their catchment areas.

Conditions in Catchment Areas.

We may for the purpose of this note divide the Himalaya into three broad belts—

(*a*) The zone bordering on Tibet,
(*b*) The inner Himalaya, and
(*c*) The outer Himalaya.

(a) THE ZONE BORDERING ON TIBET.

The great Himalayan range forms a barrier beyond which the effect of the south-west summer monsoon is very slight and the sources of water supply are the glaciers and winter snow near the Tibetan border. The country is desolate in the extreme and only where water channels have been built is cultivation possible. A few briars and junipers occur at wide intervals; carragona and wormwood bushes take the place of grass, but usually there is nothing but bare precipices and rock screens. At high elevations there is sometimes a little grass and in side valleys some forest. Vegetation here is scanty and has little effect on the water supply.

(b) THE INNER HIMALAYA.

As the region of monsoon rainfall is approached vegetation appears and forests, which at first are confined to the side valleys, gradually cover the uncultivated slopes. To the south of the great Himalayan range vegetation increases; forests clothe the catchment areas in a continuous belt; above and below them are wide stretches of grass-lands, many of which are fired annually for the sake of improving the grass. There is no doubt that the whole country was formerly covered with forest and that trees have been ousted from the present grass-lands by fire. Shifting cultivation aided and hastened the disappearance of the forest, but has been put a stop to within demarcated forests since British occupation.

In the forests the soil is deep and moist and when the trees were cut and burnt magnificent field crops were raised, but at the end of three or four years the soil had largely eroded and had become sterile. The land was allowed to lie fallow for many years until a fresh crop of bushes or trees again covered the ground and was burnt for manure.

Below the main forest belt the ground was terraced and field crops were raised; as the forest disappeared the soil became thin and sterile and capable only of supporting a thin crop of grass. Over large areas in the Sutlej valley there are remains

of cultivated fields which are now incapable of carrying field crops except in a few favoured places where the soil has been retained. The springs have dried up and no longer is there sufficient water for irrigation.

The more valuable forests have been demarcated and worked for timber for export, but as the price of timber in the plains rose some Indian States took advantage of rising prices to cut down their forests of which the Suket State in recent years forms the worst example. During the war the Suket forests were cut down till in 1919-20 the Commissioner asked for them to be inspected: every timber tree in accessible areas was felled or marked for felling, and although a temporary check was given to exploitation in 1920 timber has since been extracted; the fires of 1921 ravaged the forests and little or no timber can now be available for future generations.

Fires both accidental and malicious are always to be feared and in 1921 in connection with the general propaganda against Government hundreds of thousands of acres of forest were burnt to the great depletion of the economic resources of the country. In 1924 floods occurred in the east of the Province and it is thought that their intensity was aggravated by the destruction of forests by fire in 1921.

Fortunately in the inner Himalaya the geological structure of the rocks is stable; grass and bushes take the place of forest when trees disappear and although the soil is eroded and becomes thin and sterile and much less capable of absorbing and retaining water the vegetation helps to prevent serious erosion and some water is retained.

The conditions of the inner Himalaya are on the whole satisfactory and no special action is called for provided always that the present forest policy is adhered to and that fires and shifting cultivation are kept in check. In the Indus catchment area the deodar forests of transborder states have been cut over heavily in recent years, but the country has lately been brought under British influence and it is hoped that the forest will be preserved.

(*c*) THE OUTER HIMALAYA.

In the outer Himalaya conditions are very bad indeed: the forests have largely disappeared and all vegetation in the village waste is subject to very heavy grazing by both local and migratory flocks which are slowly but surely destroying all tree and bush growth. For details regarding the disappearance of the forests you are referred to Mr. Holland's Report on denudation and erosion, 1928.

Throughout the outer hills forests have either entirely disappeared from the village waste lands or are in danger of extinction. Tracts of land are still scantily covered with trees, but one feature is common to all forests such as are not demarcated as reserved or protected forests under the control of the Forest Department, namely the complete failure of reproduction of any species except the more xerophytic bushes, such as *Carissa*, *Dodonea* and *Adhatoda vasica* which are not liked by sheep and goats. Over wide areas the destruction of the forest growth has laid bare the soil; the grass itself has disappeared and the productivity of the locality has most seriously diminished.

On the Tertiary formations the hard sandstones interbedded with clays prevent the formation of extensive landslips; but surface erosion is universal and no check is given to excessive run off; the streams come down in rapid spate and carry off the rain water directly it falls and soon abate and form mere trickles of water, whilst the country rapidly dries up. On the Siwalik formation of friable sandstones and pebble beds the disappearance of the forest cover is immediately followed by deep erosion and the formation of ravines; the streams carry thousands of tons of sand and sediment to great distances and have frequently destroyed large areas of fertile land in the plains.

It may be thought that we are exaggerating the evil: we know that we have understood the case and will end with a quotation dated 1877 from the Punjab Land Administration Manual, paragraphs 728 to 730, concerning the Hoshiarpur *chos*.

"728. EFFECTS OF DENUDATION OF SIWALIKS ON CULTIVATED LANDS IN THE PLAINS.

A generation later the effect of the denudation of the low hills, which inevitably resulted from the policy then adopted, on the rich Siwal tract of Hoshiarpur and Jullundur had become so great that the matter was forced on the attention of Government. The Deputy Commissioner, Mr. Coldstream, and the Conservator of Forests, Mr. Baden Powell, united on urging the necessity of prompt remedial action, and the Commissioner of Jullundur, Mr. Arthur Brandreth, strongly supported them.

729. MR. BRANDRETH'S PRESENTATION OF THE CASE.

His graphic description of the effects of neglect is worth quoting:—

"The lower Siwalik * * * * is a long low range of sandy hills which stretch across the whole of the Jullundur-Doab, forming the northern boundary of that fertile and productive tract. In the days of the Rajas, when the village common was the property of the Raja or lord of the manor, and not made over to the peasantry, these hill slopes were covered with a low stunted brushwood with a few trees here and there * * * This manor forest growth was not of great value to the Rajas or to their successors, the Sikh kardars, but it yielded a sort of cover for game, and was consequently generally protected; and as the towns were not then very wealthy, and peasantry had hard enough work to produce the heavy revenue then demanded there was little demand for fuel, and few persons with leisure to cut it.

* * * * * *

"The stunted brushwood had, however, one great value. It covered the sandy soil by its roots and by the grass which grew in its shade. The cool air from the shaded hill-side arrested the passing clouds and produced a constant and almost regular rainfall, which, checked by the leaves of the brushwood and grass, poured down the hill-sides at a gentle pace, and, bringing with it all the soluble products of the decayed leaves and grass, spread its wealth-laden waters over the plains below, which thus became

so renowned for their fertility as to be known as the garden of the Punjab.

"The scene now is far different.

* * * * * *

"The hill-sides were divided among the villages located on the hills, and the whole brushwood and minor forests declared to be their property village common open to every one.

"With the introduction of English rule, towns increased, wealth and property abounded, and the cessation of the continual demand for forced labour created a class of labourers with abundant leisure, and in search of employment. With the increasing wealth arose increased wish for comfort, and a large demand for firewood of all sorts consequently soon sprung up, and the unemployed class found the brushwood and low jungal of these hill-sides a mine of wealth open apparently to every one. With our large public works and railways the demand increased still more, and the hill-sides were consequently in a few years stripped of everything that could by any possibility be used for firewood. Where the distance from the towns was too great the still more destructive charcoal burner appeared on the scene and consumed three times the amount needed to render his firewood portable. It might be supposed that the new proprietors would have taken some steps to protect their quasi-forests, but the sense of proprietorship was new, and they were in doubts how far they were entitled to interfere. Most of the labourers and woodcutters were residents of their own villages, and what is everybody's business is nobody's business, and consequently none of the former copyholders, now all become joint owners, endeavoured to check this waste: indeed, on the contrary, they rather encouraged it. Many persons paid them some little sum for the rights of cutting and the charcoal burners generally paid Rs. 2/- or Rs. 3/- for a year's license. They could not be expected to consider the future loss to their children, still less to care for the villages below the hills, which were slowly being ruined.

"Yes, I may almost say ruined, the injury is so great and so increasing. As the bare hill-sides have replaced the green forests,

the heated air of the dry sandy soil drives off the rain clouds to pass on to the upper ranges. When, owing to the increasing pressure of the clouds, rain does at last fall * * * the condensation produced by its fall on the heated soil produces * * * a great downward rush of the heavily laden upper air, and the * * * late rain soon descends in torrents. The fall is no longer arrested by leaves and brushwood and grass, and the increasing torrent pours rapidly down the sandy slopes, bearing with it thousands of tons of sand instead of the fertilising deposits of former days. These vast floods spread themselves over the village below, tearing away all the fertile fields which formerly lined the edges of the stream, and covering the rest of the country with a deep sandy deposit. For the first few years this sandy deposit was not so very injurious. It was fresh soil and still held a good deal of the decayed roots of the grass and brushwood of the former vegetation. Moreover, a thin layer of sand is often a great protection to an Indian soil: it protects and supports the young and tender plants, and enables the soil below to retain its moisture for a long period. But gradually the tale became very different. Constant reports of deteriorated crops and distressed villages and tenants unable to pay their revenue replaced the uniformly prosperous report of former days: traffic and trade was checked by the great development of these vast sandy beds, which intersected all the main roads: and further demands for remission began to pour in from villages beyond the action of flood, but whose fields were being buried by the masses of dry sand brought from these torrent beds by the windstorms of the hot weather. Nor was the injury confined to the agricultural peasantry only. The increased volume of waters thus suddenly brought down soon carried away the bridges sufficient for former times and compelled a speedy extension of "waterways" and further expensive bridging both on the Grand Trunk Road and the Railway, and when even these proved insufficient the waters submerged the country far and wide. * * * *"

730. RESULTS OF DELAY IN TAKING ACTION.

The picture is highly coloured, but it can hardly be said to be exaggerated. Soon after in reporting on the assessment of

the Hoshiarpur tehsil Captain J. A. L. Montgomery pointed out that, owing to the destructive action of the *chos* or sandy torrents issuing from the Siwaliks, cultivation had decreased by 12 per cent. in 30 years.* As we shall see, action was greatly delayed, and things went from bad to worse. In 1897 the Financial Commissioner wrote:—

"During the last period of ten to twelve years on account of the action of the *chos* in Hoshiarpur and Jullundur 16,650 acres of land have been converted into *cho* beds, or have totally lost their productive power, while 23,260 acres in addition have been damaged. Government has remitted Rs. 11,855 land revenue, and has in addition suffered or is about to suffer by reductions in the rent rolls of the two districts an annual loss of Rs. 34,719 land revenue, while the people have lost at a low estimate over 20 lakhs of rupees in the market value of their lands."

The *chos* increase in size every year despite remedies provided by the partial application of the *Chos* Act 1900, the water level is sinking in the Hoshiarpur, Jullundur, and Amballa Districts and enquiries are now being made by Irrigation Specialist Officers as the fertility of large tracts is endangered. This apart entirely from the danger to canals and the shortage of winter supplies in the Punjab rivers.

SUMMARY OF THE CAUSES OF THE RECENT DISAPPEARANCE OF THE FORESTS.

Previous to the British occupation the Punjab was in a very disturbed state and life and property were unsafe. Each little hill baron lived in his castle and his people pursued precarious occupations within the enclave of the state protected by the troops, and raids and fighting were common. No one could wonder far afield without armed protection and the migrations of nomadic flocks were by no means so extensive as

* The action of *chos* is not purely destructive. Far away from the hills after the heavier sand has been dropped, the deposits they spread are often very fertilizing. But wherever the hills from which they run are denuded of vegetation and consist of sandstone rocks, loss must far exceed gain.

they are at present. To quote from Lyall's Land Revenue Settlement of the Kangra District 1865-1872: "I have heard old shepherds say that down to British rule it was like running the gauntlet to convey a flock across the low country to its 'ban' (winter grazing ground). Every petty official or influential landholder tried to exact something as the flock passed him: a mild man easily daunted had no chance, and the *gaddis* picked out their ugliest customers for the work."

With the peace and prosperity brought by British occupation not only did local flocks increase but they wandered farther from the homestead and literally ate their way through the forest: a superimposed burden was and still is the grazing and browsing of nomadic flocks. During the summer they graze on the luscious pastures of the high hills whence during the autumn, winter and spring they are forced down by snow and spread over the lower foothills devouring any vegetation that is left in a constant endeavour to tide over the winter till they can once again enjoy the luxuriant pasturage of the high hills. There is not enough for these flocks to eat: *gaddis* from Kangra with numerous flocks of sheep and goats, graziers from Kanawar and the high hills and Gujars with numerous buffaloes all compete with the local village flocks for the rapidly disappearing fodder, and year after year as the supplies are lessened competition therefore is greater. Not only are grass and bushes grazed to the ground but the branches of all fodder trees are lopped and eventually the trees die and the forest disappears. The early land revenue settlements are much to blame—the Settlement Officers did not realise the consequences of a weak forest policy on the destruction of natural resources.

The Rajas had regarded the forests as their own special property and prevented encroachments thereon and grazing therein as interfering with their sport: as a consequence the forests were intact when the British first occupied the Punjab. The first British land revenue settlements handed over such areas to the villagers as *shamilat,* or village common lands, and as the villagers realised that they now had rights in lands from

which they had previously been excluded each man endeavoured to gather what he could for his own and reaped a present advantage from the sale of firewood to the nearest cantonment or town which sprang up shortly after the land was conquered and peace prevailed.

REMEDIES.

The means to be adopted are the limitation of flocks and herds to the capacity of the country side, the introduction of systematic pasture management and the preservation of the village waste and the forests from abuse. Early and serious steps must be taken to foster and preserve from destruction the scanty remains of the once extensive forest.

Proposals have recently been made for dams below catchment areas in order to increase the winter water supplies of the rivers; these dams can only be constructed at vast expense and we think you will recognise that they are of little effect as compared with the immense reserves which nature herself provides in the form of forests, and would not be required if proper forest and land revenue policies had been pursued. Engineering works made by man are expensive, are mere palliatives and do not remove the disease itself; we must look farther afield and seek our remedies in a more suitable management of the waste lands of the Province.

[*This paper was read at the Punjab Engineering Congress.*—HON. ED.]

EXTRACTS FROM :—OBSERVATIONS ON THE EXPEDIENCY OF SHIPBUILDING AT BOMBAY FOR THE SERVICE OF HIS MAJESTY, AND OF THE EAST INDIA COMPANY.

BY WILLIAM TAYLOR MONEY,

Late Superintendent of the Marine at Bombay.

(*Continued from pages 527-538, December 1930 number.*)

" Humanity is concerned in the measure proposed, inasmuch as it will increase the safety, or rather diminish the risk to which the lives of our seamen are exposed, as well those who fight the battles of their country as those who extend its commerce to the most distant regions of the globe.

" Whatever tends to render ships more durable, must render them more secure. It has been shewn that teak ships must be more durable than oak because the one possesses properties of self-preservation and the other of self-destruction. Can humanity hesitate which to prefer?

" His Majesty's ship sceptre, of seventy-four guns, Captain Bingham, which had been built in England in 1803, sailed from Bombay for England in May, 1807, and had accomplished the greatest part of her passage to the Cape, when she sprung a dangerous leak, and it was not without difficulty and incessant exertion that she was preserved from foundering. Captain Bingham bore up for Bombay; but such was the perilous condition of the ship, that he was under the necessity of hiring a Portuguese vessel at Mosambique, for the purpose of accompanying the sceptre, to receive her crew in the event of the extreme necessity occurring for abandoning the ship. She, however, fortunately reached Bombay with a sail under her bottom, in the end of July; and when hauled into dock it was discovered that the dangerous leak principally arose from the penetration of worms in the bottom plank, about eight feet under water close to the wooden ends, where they had entirely eaten a hole about seven inches square and in many other parts of the ship, where the copper was off, had nearly perforated the bottom, and entirely destroyed the gripe.

" Many other instances might be adduced of the injury and decay to which oak ships are exposed, and from which those

built of teak are exempt; but the two which have been selected are, it is presumed, sufficient to shew from what imminent perils the valuable lives of our seamen may be saved by the adoption of the measures proposed.

"It has been objected to Bombay ships, that they are rudely put together—that the scantling of their timbers is disproportionately large—that they are built by the eye and not by the rule; that, in short, they are not constructed according to the principles of science.

"The last seven years have fortunately furnished conclusive answers to these objections in the beautiful and durable specimens of naval architecture, which have been supplied in that period from the dockyard of Bombay, for the service of his Majesty and of the East India Company.

"The first of these was the Salsette frigate, and, in proof of her good qualities, the author submits a quotation from a letter dated Plymouth, December 25th, 1809, from Vice-Admiral Sir Edward Pellew, who, if he is persuaded, will readily excuse the use here made of a private communication, since it tends to the honour of the Port of Bombay, which has been so deeply indebted to him for the protection of its commerce, and to the credit of a man to whose merits he has ever been anxious to render justice.

"I beg to make Jemsatjee Master Builder, proud of his frigates. The Salsette sails as well as any of ours, stands up better under canvas, and, had any other ship been frozen up in the Baltic as she was, for nine weeks, Captain Bathurst says she would not have stood the buffeting of the ice one day, whereas the Salsette came off unhurt. It was wonderful the shocks she resisted during heavy gales."

"After the completion of the Minden, seventy-four, the author considered it his duty, on surrendering his charge to the Naval Commissioner to request his professional opinion of the first ship of the line ever built for the navy out of England—and Mr. Dundas favoured him with the following satisfactory answer:—

"In replying to your letter of yesterday's date, wherein you request I would state my opinion of the construction and finishing

of H.M. ship Minden, I beg to say, that on my arrival here, in May 1809, I visited the Minden with an earnestness and carefulness of enquiry, that I considered due to the undertaking; at the period of forwardness I first viewed the ship, her principal timbers were all open to inspection; with such timbers I could not but be highly delighted, as certainly very many of them I have not seen equalled in the building of any ship in England; the mode of securing the beams by dovetailing them into strong clamping planks (a method not used in the King's yard) gave me much satisfaction as much strength is thereby given to the ships. As the work was carried on towards completion, I continued daily watching the progress, and must declare was at all times pleased with solidity of the work, as well as with the manner of its being put out of hand; and I can have no difficulty in giving it as my opinion, that she will be found to be as well put together, and as highly finished, as any ship built for the British Navy."

"I can only add my hopes, that while the Minden remains a proud proof of what may be expected from Bombay, she will add to that credit the builder has already gained in the opinion of those who, having had opportunities, are capable of setting a just value on his abilities."

"To command this noble man of war, and to try the merits of the first experiment of an Indian built ship of the line, Captain S. W. Hoare, was selected by the Commander-in-Chief; and the following comparative statement of the properties of the Russel, which had long been a favourite in the navy, and particularly with the late Admiral Drury; and of the Minden, which had been fitted for his flag, was obligingly furnished to the author by Captain Hoare:—

RUSSEL.	MINDEN.
In smooth water with all sail set, on a wind will go from five to eight knots, but not stiff.	In smooth water with all sail set, on a wind will go from seven to nine knots, and does not complain with this sail.

RUSSEL.

With top gallant sails and much sea, will go from three to five knots, according to the swell; she plunges a great deal, and carries her helm a turn a weather.

Under her topsails behaves much the same, will stay under them in smooth water, and veers and stays well.

With the wind from one point free to a beam, will go seven or eight knots. Her best sailing is with the wind abaft the beam, she will go eight or nine knots. Before the wind she rolls easy; she carries her lower deck ports badly.

Height of ports when stored for 6 months.—

		F.	I.
Fore port	...	5	5½
Midship	...	4	3½
After ditto	...	4	11½

MINDEN.

Under top-gallant sails, and with much sea, will go from five to seven knots, according to the swell, and very easy; she carries her helm half a turn a weather.

Under her topsails behaves much the same; will stay under them in smooth water, and veers and stays well.

Her best sailing is before the wind, she will then go nine or ten knots, she rolls easy, and carries her lower deck ports well.

Height of ports when stored for 6 months.—

		F.	I.
Fore port	...	6	3½
Midship	...	4	9½
After ditto	...	6	1½

"With such specimen of men-of-war as are exhibited in the Minden and Salsette, and in the Doris too, which though not so fast a sailor as some of the frigates of the squadron, yet abounds with other good properties to which her commander, Captain Cole, has frequently borne testimony, every inducement is supplied to render this great naval arsenal conducive to the augmentation of the British navy, and no less encouragement is furnished to the East India Company to prosecute shipbuilding for their own service in this their own dockyard, by an inspection of the Charles Grant, the Earl Balcarras, and the Abercromby, which are universally pronounced to be the finest merchantmen in the

world, and with which the Herefordshire, in the course of a year, may be classed as a rival in stability of construction and beauty of form.

"In the two dockyards of this port there is capacity for building at the same time two ships of the line, two frigates and a large and a small Indiaman, the whole of which, by a proportionate increase of the establishment of artificers, easily effected may be completed within the period of eighteen months; so that, in the course of fifteen years, British navy may receive an addition of twenty seventy-four's and twenty frigates, calculated to last in substantial condition for half a century.

"Although some instances of the durability of teak have already been noticed, it may be here proper to state a few striking proofs, that the estimated extent of the durability of ships constructed with that unequalled wood, has not been the result of light conjecture, but of a fair application of precedents furnished in times when the noble art of shipbuilding had not attained the perfection at which it has now arrived, and which superadds the strength of scientific construction to the advantage of the wood.

"The present Turkish flag ship at Bussorah, was built by Nadir Shah, before his march to Delhi, and therefore, at the latest period, in 1738; about eight years ago this ship was in dock at Bombay for repairs and her timbers ascertained to be perfectly sound.

"Mr. Nicholas Hankey Smith, the Hon. Company's Resident at Abooshiher, states, that during his late residence at that place, he saw one of the teak vessels built by order of Nadir Shah (which, he was informed, had been upwards of twenty years under water), broken up, and the plank and cotton in her rabbit work appeared to him as fresh as if the ship had been recently built.

"It may be proper to notice that this vessel had been sunk by the Arabs, who were compelled by the Persians to serve as part of her crew.

"The ship Hercules, of 485 tons, was built here in 1763 and constantly employed in the trade of this part, till 1805, when she was captured off the Cape in her voyage to Europe. When she sailed from Bombay she was in a perfectly sound condition with every appearance of ability to double the course of time she has already so actively run.

"The ship Milford, of 679 tons, and belonging to this port, was built in 1786, and after constant employment in the trade to China, and occasionally to Europe for twenty-four years, received her first thorough examination in 1810, when it was not found necessary to shift a single timber and the whole expense of her repairs, including a new set of chain plates, amounted only to 1000D.

"It is also worthy of remark, that the same teak mainmast which she had when she first went to sea, continued in her for one and twenty years, and then being partially sprung, was converted into a mainmast for a smaller vessel.

"The stock of timber and plank at Bombay, the gradual collection of years since the first order to build men of war in 1802, is equal to three years' consumption; and one by systematic arrangements in the forest department, now one of the principal branches of the public service, will be annually replenished from Canara and Malabar. Some of the forests abound with the largest teak, straight and curved; in others more contiguous to the sea-coast, great devastations have been committed by the timber merchants, who till lately were under no check or control; but by judicious regulations, which prevent the felling of young trees, and secure a replantation of the naked tracts, these valuable provinces will, in a few years, contain inexhaustible resources for the dockyard. In the meantime they are fully equal to answer any demand which shipbuilding to the utmost extent proposed can possibly create.

"In addition to these resources from the southward, an annual supply of compass timber is procured from the country to the northward, between this port and Surat, where a regular trade has been established, employing considerable capital, and several thousands of the native population."

ON THE LEGAL ASPECT OF RANGERS' WORK.

(*A lecture delivered by Mr. K. Achutha Nayar, B.A., Stationary Sub-Magistrate, Coonoor, to the Students of the Forest College.*)

GENTLEMEN,

Your senior lecturer asks me to address you on the legal aspect of your work. I do so readily. You are entitled to any little help I can render you. I have decided to reduce to writing what I have to tell you, to avoid omission and to ensure the use of apt words as far as possible. Of course it is not possible to discourse exhaustively on this wide subject in a short address nor do I claim that what I have to say is absolutely correct in every detail. If you derive some benefit from my effect neither your time nor mine will have been spent in vain. Questions regarding substantive law, evidence and procedure have to be touched upon.

2. The duty of Forest Officers engaged in forest cases is the same as that of other officers dealing with cases as investigators or prosecutors. An investigating officer's duty is to collect and to arrange his evidence. It is not his duty to attempt to fill up artificially gaps in the evidence; at the same time he has to collect all evidence that appears to have a direct bearing on the case. This evidence has to be scrutinized later to see how much of it actually is relevant. This requires that the investigator can refrain from charging a case only if there is no reliable evidence or if it is so scanty as to be treated as negligible. In other cases the duty of weighing evidence rests solely on courts before which the matter has to be laid. This duty rests on the prosecutor as well. A prosecutor's duty is not to aim at a conviction primarily, but state his case fair and square. According to the highest conceptions a prosecutor is an assistant to the Court to help it to arrive at a correct decision; the idea of securing a conviction has only a secondary importance.

3. We shall now turn to the most important part of the subject *i.e.* the collection and presentation of evidence. The term evidence is defined in Section 3 of the Evidence Act as meaning and including (1) all statements which the court permits or requires to be made before it by witnesses in relation to matters of fact under inquiry; (2) all documents produced for the inspection of the court. In criminal cases and in forest cases in particular oral evidence is almost all important; hence without impropriety you can confine yourself almost exclusively to such evidence. Now

the main point for your consideration should be how to obtain the best evidence and how to present it before a court in a proper, clear and logical form. It goes without saying that you want the best evidence. This is the most fundamental principle underlying the Evidence Act. Naturally and from an intelligent point of view it is clear that evidence has to be valued more with reference to its quality than quantity though the latter is important in a minor degree. The value placed on quality is recognised in Section 134 of the Evidence Act which lays down that no particular number of witnesses shall, in any case be required for proof of any fact. This does not mean that corroborative evidence is not necessary but only that a case cannot fail merely because there is only a solitary witness to prove the offence. Take a case where a woman is outraged. Such an offence naturally is not committed in the view of other people. The only persons present are the offender and the woman outraged. In such cases it is impossible to expect evidence other than that of the woman outraged, to prove the actual outrage though medical evidence is essential wherever procurable to prove the injuries on the woman. If the woman is consistent in her evidence and is not broken in cross-examination a conviction on her sole evidence supported by that of the medical witness will be sound in law.

4. The next important point is that oral evidence must, in all cases whatever, be direct. This principle is laid down in Section 60 of the Evidence Act which lays down the following principles ;—

(*a*) If the evidence refers to a fact which could be seen it must be deposed to by a witness who saw it.

(*b*) If it refers to something heard the evidence must be that that of the person who heard it.

(*c*) Similarly if the fact is that a person perceived something by the exercise of some other sense that man must depose to this fact as a witness.

There is yet another reason why the person actually concerned and who has direct knowledge of the facts to be deposed to, should be examined as a witness. It is that the court hearing the case should form an estimation of the value of the evidence tendered from the demeanour of the witness. This is laid down in Section 363 Cr. P. Code. A witness might have tendered his evidence in a straight-forward manner, in a halting way, or might have prevaricated without actually having spoken an untruth. His evidence has to be assessed according to his demeanour in the box.

Unless a witness having direct knowledge of the facts of a case is in the box, no court can record remarks on this important point. Unfortunately it is not possible always to get evidence of the nature referred to in Section 60 of the Evidence Act. Such exceptional cases are provided for in Section 32 and 33 of the Evidence Act which permit statements, written or verbal of relevent facts made by a person who is dead, or who cannot

be found, or who has become incapable of giving evidence, or whose attendance cannot be procured without reasonable delay or expense according to the opinion of the court to be accepted as relevant without those very persons being placed in the box. In like circumstances evidence given by a witness in a judicial proceeding is relevant in a subsequent proceeding or in a later stage of the same proceeding to prove the truth of the fact deposed to. To take an example supposing that a Range Officer investigating a forest offence has recorded the statement of a Forest Guard who has direct knowledge of the case. If unfortunately that guard is not available at the hearing of the case on account of one or more of the reasons referred to in Section 32, the Range Officer can prove the statement recorded from that man. If in a case there are more accused than one and if one or more are not available to be put on their trial till after the case against the others has been disposed of, and if the guard who was examined as a witness at the first hearing is not available at the trial of the accused who were absent originally but whose attendance was secured subsequently, that man's deposition in court can be proved either by the Range Officer present when it was recorded or by the clerk of the court. Another exceptional case in which the personal attendance of a witness can be dispensed with is under chapter XL, Section 503 of Code of Cr. Procedure which permits the examination of witnesses on commission. Supposing that when a case comes on for hearing at Tuticorin, a Forest Officer who is a witness is at Dehra Dun, his personal attendance can be dispensed with and he can be examined on commission. In that case a list of questions both for the prosecution and for the defence should be forwarded to the 1st class Magistrate having jurisdiction over the latter locality, *i. e*, Dehra Dun.

5. Having seen what sort of evidence, broadly speaking, you have to secure, you have to see now how to obtain it. For this purpose the investigating officer invariably must reduce to writing the examination of all persons questioned by him, whether they are accused persons or witnesses. Turning to the statements of accused persons it is evident that these are either admissions or denials. If the latter, the necessity for further investigation is apparent. If accused person makes an admission it is valid against him always. An admission can be proved on behalf of the person making it only to establish his innocence or good faith in any case against him. 'A' is accused of an offence alleged to have been committed by him on certain date at 'B'. He can prove a card posted by him on that date at 'C' which is far away from 'B'. Again 'A' is accused of having in his possession properties knowing them to have been stolen. He can prove that he offered them for sale to 'B' openly and at their proper value. An exception to the law that an admission by an accused person is valid against him is to be found in section 24 of the Act which lays down that no confession is relevant if the making of it appears to the court to have been obtained improperly by some person in authority competent to condone or to mitigate the offence, provided the person

making the confession believes that by making it, he will gain an advantage or avoid an evil. If the confession referred to is made after the removal of the improper impression created in the mind of the accused person, it (the confession) becomes relevant under Section 28. If a Forest Officer having power to direct a case to be charged or dropped holds out some improper promise to an accused person, with regard to the case against him and thus induces a confession from him it is inadmissible. If on the other hand, that officer does not carry out his promise to the accused person within the time stated and in consequence the accused person ceases to expect any advantage from that officer and subsequently makes a confession it does not become invalid. Section 29 goes on to add that a confession obtained under certain conditions also is valid against the person making it. Such conditions exist when the confession is made under a promise of secrecy, or in consequence of a deception practised on an accused person for obtaining it, or when he was drunk, or when it was made in answer to questions which he need not have answered. It is well known law that an accused person cannot be compelled to answer any question put to him and that any statement made by him is privileged absolutely, however false or defamatory it might be. Then again if more accused than one are tried jointly a confession made by one of them implicating himself and one or more of the others can be taken into consideration against such other or others of the accused. See Section 30 of the Evidence Act. This provision of the Evidence Act is followed with great caution by courts and generally only when such accomplice evidence, as it is termed, is corroborated by other evidence. The reason is not far to seek. Human nature being what it is, offenders consider it as something gained if they can implicate others also, even if they cannot escape themselves. This caution is recognised in Section 31 which states that admissions are not conclusive proofs of the matters admitted. A person making an admission is entitled to prove later that it was made when he was under a wrong impression.

6. Having seen that the statements of accused persons and witnesses have to be reduced to writing you have to see how much of the matter collected has to be adduced as evidence. The general principle is laid down in Section 39 of the Evidence Act which states that only so much as is relevant should be let in as evidence. In plain language witnesses must be questioned to the point and made to answer to the point. This part of the subject is termed relevancy of facts and is dealt with in Sections 5 to 11 of the Act. Section 5 states that the evidence may be given of the existence or non-existence of facts in issue or such other facts which are declared to be relevant. Section 6 states that though a fact is not in issue it becomes relevant if it is connected closely with the former. It is not essential that the incidents should have taken place at the same time or place. Section 7 states that facts which being about the existence of facts in issue also are relevant. Section 8 lays down that any fact which disclosed a man's notice, preparation, or subsequent conduct with

reference to any act of his becomes relevant when that act itself is a fact in issue. Section 9 enunciates that when a fact is in issue, facts necessary to explain or introduce it themselves are relevant. Section 10 states that when two or more persons conjointly engage themselves to commit an offence anything said or done by one or more of them with reference to their common object becomes a relevant fact. Finally, Section 11 states that facts not otherwise relevant are relevant, (1) if they are inconsistent with any fact in issue or relevant fact, (2) if themselves or in connection with other facts they make the existence or non-existence of facts in issue or relevant facts highly probable or improbable.

If you were to indict a man for illegal hunting in a Reserve Forest in the Coimbatore District on a particular date he can prove that on that date he was at Madras. If 'A' and 'B' are accused of illegally hunting in a Reserve, 'B' can prove that he could not have discharged a shot being incapable of handling a gun. In brief the object of Sections 5 to 10 is to restrict the letting in of evidence to relevant facts and to other facts directly bearing on them.

7. Your next concern is to see on whom rests the duty of adducing evidence, or in legal phraseology, the burden of proof. For this you have to go to Sections 101 to 106 of the Act. Section 101 states that if a person desires a court to accept the existence of a fact he must prove it. Naturally it follows that a prosecutor has to prove his case, as in the absence of evidence on either side he will be taken to have failed. This is Section 102. If reliable evidence is adduced against an accused person but, if he still claims that he is not guilty in view of some provision of law or other exceptional circumstances the burden of proving that he is not liable lies on him. In a case of illegal hunting a man is found cutting up a wild animal within a Reserve. If he claims that it is not a wild animal or that it was shot outside the reserve he has to prove his contention. This is Section 105. In a case of illegal grazing within a reserve if the grazier claims that he had a valid permit the burden of proving the existence of that document is on him. This principle is laid down in Section 106. In a nutshell the point is that if you want a court to believe the existence of any fact which you claim does exist you have to prove it unless its existence is noticeable judicially by the court, (Section 57) or is admitted under Section 58, or the burden of proving it rests on any particular person under Section 106.

8. The next point is whom all you can put into the box to let in the evidence collected. According to Sections 118 and 119 any man is competent to testify, including even a deaf and dumb person, unless he is incapable of doing so by very tender years, extreme old age, or disease. The point is whether witnesses can be made to understand proceedings and to give rational answers to questions at least by signs. It is better to examine a smaller number of witnesses who are reliable than a larger number of persons who contradict one another and spoil your case.

9. The next point is the handling of witnesses in the box. For this the important Sections are 141 to 143. Your questions must be choice and few and not made at random. Unguarded questions are pounced upon readily by the opposite side to break your witness in cross-examination. Each question with its answer must forge a link in the chain of relevant facts from the beginning to the end. All questions must have the same ultimate end in view *i.e.*, to prove your case, nothing more and nothing less. Questions which are mere verbiage, or intended merely to annoy a witness should be avoided. There is no objection to put questions to a witness against you to test his veracity or to impeach his credit provided you can justify such questions if asked by the court to do so. There is no use of fighting over trivial or irrelevant questions only to lose; such an attitude will tell against you. Persist in getting such questions accepted which really will serve you and which you can justify. Ordinarily, leading questions (those that suggest the answer wanted by the questioner) are admissible only in cross-examination. They are admissible in examination-in-chief only to introduce matters or when they relate to undisputed points.

10. Witnesses are of different temperaments. Some are overbold and too talkative while others are timid. Some are distinctly hostile. You have to adopt a cold and rigid attitude when dealing with the witnesses who are too forward; in the case of timid people it is well to adopt a friendly and conversational tone to inspire confidence in them and to allay their fears. You must deal with hostile witnesses cautiously and not let them detect your aim till they have committed themselves by an answer that tells against them. Then you can turn the tables on them by confronting them with contradictory statements made before you during investigation. It is then that the court will be convinced that you have ample justification to treat the witness as hostile. It is idle to expect any court to accept that a witness is hostile merely because he does not give you the answer you want. When a witness is treated as hostile the party calling him can cross-examine him, and this is a right that will not be granted lightly.

11. Now you have finished your work in connection with cases from investigation to the examination of witnesses. Little or no argument will be necessary in Forest cases as generally they are simple and not intricate. In brief your object as stated already is to collect and to present evidence in the shape of a connected and relevant chain of facts. You know that no chain is stronger than its weakest link. So every link must be strong enough to stand the tension put on the chain as a whole; else the chain snaps. To drop the metaphor unless you have a logical and conclusive sequence of facts in support of your case it will not be worth while to charge it. It is another matter if your witnesses are floored in relentless cross-examination. Even then courts see whether the case has been proved on material points. It is well known that natural as apart from artificial evidence usually will be discrepant on minor points, but cases do not stand

or fall on these. If you are thoroughly prepared with your case and if your witnesses know on what material points their evidence is required it will not be difficult to present acceptable evidence. It is not at all meant that you should coach or tutor your witnesses. All that is required is that you should be prepared with a well threshed out case. You know that the law presumes every man to be innocent until he is proved to be guilty; that the benefit of every reasonable doubt is in his favour and that even if a hundred guilty men escape one innocent man should not be convicted.

12. Having dealt with matters relating to evidence it might not be inappropriate to touch lightly on questions regarding procedure and the sections of the Penal Code that will be useful to you. Generally speaking Forest cases are summons cases *i.e.*, they are punishable with imprisonment for a term of six months or below, leaving alone fines, see Section 4, Cr. P. Code, Cl. (v) and (vi). The procedure for trying such cases is laid down in Chapter XX of the Code of Cr. Procedure. The procedure is more or less summary as compared with that laid down for the trial of warrant cases. In a summons case the court starts with the complaint which is considered to be sufficient matter on which to ask the accused to plead. In summons both sides have to produce their evidence—Section 244 Cr. P. Code. This means that no summons will be issued ordinarily unless Government or Railway officials or such like are cited as witnesses. Summons cases are expected to be finished at one hearing. If after the witnesses for the defence are examined there is material evidence yet to be let in for you, you can ask the court to examine fresh persons as court witnesses under Section 540 Cr. P. Code. If the court is convinced of the justice of your claim it readily allows it as the aim is to see that substantial justice is done.

Warrant cases involve a more detailed procedure. There you have to establish a prima facie case before a charge can be framed against the accused to which he will be asked to plead. If you do not make out a prima facie case the accused will be entitled to a discharge. In the case of a discharged person the court itself can revive proceedings if adequate grounds are made out or if the District Magistrate or other superior court directs a case to be reopened under Chapter XXXIII of the Cr. P. Code. In a summons case no charge is necessary to be framed; so there can be only an acquittal if the accused is not found guilty. In the case of an acquittal whether of a summons case or of warrant case there is a right of appeal only on behalf of the Government under Section 417 Cr. P. Code. To mention an instance of a warrant case under the Forest Act see Section 50 of that Act.

13. Ordinarily Forest officers have little or nothing to do with offences under the Penal Code. The only sections with which they need concern themselves are those relating to abetment (Ch. V) and to those relating to property (Ch. XVII). As imprisonment is one of the punishments prescribed under the Forest Act for Forest offences they are capable of being

abetted. If A puts on B to graze cattle in a reserve without permit he abets that offence by instigation. If A, B and C engage with one another illegally to hunt in a reserve and in consequence of it an illegal hunting takes place, A is guilty of abetment by conspiracy even though he was not present at the actual hunt. If A helps B with men and implements illegally to gather forest produce or afterwards supplies carts to the latter to remove the produce collected, he abets the offence by aid. In this case if A was present at the locality at the time of the commission of the offence he is punishable under Section 114 I. P. C. read with Section 21 (f) of the Madras Forest Act; if he was not present, with the said section of the Forest act read with Section 109 I. P. C. Under section 289 (B) Cr. P. Code persons accused of an offence and persons accused of abetment of that offence can be tried together. So you can include them in the same complaint. As regards offences under Chapter XXVII of the I. P. C. it is better to leave the investigation to the police as such offences are cognisable by them [Sec. 4 (b) Cr. P. Code] and being better trained to investigate offences they can be expected to deal with them more satisfactorily. The only cases in which the Forest officer need take action in offences against property are when immediate arrest is desirable as when the culprit is caught red-handed with the property or when an immediate search is necessary of a place where stolen property is deposited. In these cases you need take action only if a police officer is not within easy reach and when delay would be detrimental to the interests of your department. If you arrest an offender it is your duty to send him before the nearest Police officer or Magistrate, for under Section 61 Cr. P. Code no accused person arrested without a warrant can be kept even in Police custody beyond 24 hours exclusive of the time necessary for the journey from the place of arrest to the Magistrate's court. In instituting searches you have to observe the provisions of Section 103 Cr. P. Code clearly which require that you should demand in writing that at least two respectable inhabitants of the locality do attend the search.

In passing it might be observed that the property in the possession of your department consists mainly of valuable trees cut and attacked or standing in plantations. Thefts and allied offences are against possession and involve a distinct dishonest intention to remove property from lawful possession. The offence is complete when the property is moved with the intent to dishonest taking. Standing trees are not moveable property till they are cut down when alone they are capable of being stolen. If you find a man laying an axe at the root of a tree his act will amount only to an attempt to commit theft—Section 511 I. P. C. read with Section 379 I. P. C. or to mischief under Section 426 of that code, according to the facts of the case.

14. Now as regards punishments ordinarily it will not be right on your part to ask courts to award imprisonments for offences under the Forest Act. The offences do not imply defect of character and in the absence of any series of serious forest offences in the same locality denoting a

determined or organised effort to defy the forest laws imprisonment will be unsuitable. Moreover, the idea of an "an eye for an eye and a tooth for tooth", meaning thereby *vindictive punishments* generally is losing acceptance gradually. The object now accepted is to reform character in jails and there is little or no occasion for such treatment in forest cases. Further, strictly speaking your department is not in possession of forest areas but merely has custody of them to manage them for the public good. The penal provisions of the forest act aim at speedy and effective remedies for proper management and *control*. Therefore generally speaking fines are better suited to meet forest offences. I have alluded to this as some officers on occasions have asked me to award imprisonment to offenders under the Act.

15. The last question is whether it is better to charge a large number of cases or comparatively a smaller number. The question really rests on the merits of each case. It is good policy not to charge trivial cases as they cause very slight injury. See Section 95 I. P. C. for this principle. If this view is good for all it ought to be better for a department of Government. I touch on this point as in my experience I have come across at least some cases of a *trivial nature* which it would have been better to have left alone. To mention a few instances, a jutka driver grazing his pony in a reserve for a few miuntes' halt during a trip, a travelling mendicant helping himself to a few dry twigs to cook his food, or a cart driver cutting a small stick to drive his bullocks are instances of trivial infringements of the Forest law which it would be wise to ignore. At the same time you should make people understand clearly that you will stand no nonsense and should take due action in the case of serious infringements involving damage on an extensive scale.

Now a last word as regards your conduct in court. Being responsible officials of Government *there is an implied* duty laid on you to conduct yourselves suitably and thus set an example to the opposite party. You must make it a point to keep your engagements in courts punctually and otherwise conduct yourself in an examplary manner so that parties might see that Government officials are the first to respect the law and the authorities constituted to administer it. If you are not able to attend court for cases you must send prior intimation to the court of your inability to be present. Cases are liable to be dismissed if complainants are absent and though Government cases are adjourned in such circumstances it is well that such a course is rendered unnecessary as far as possible. If you do not turn up in time avoidable delay in the disposal of cases and needless dislocation of the court's programme are caused. Besides you know the well-known sayings (1) Speedy injustice is better than tardy justice and (2) *Justice delayed is justice denied*. If ultimately the accused is acquitted in a case which has had to be adjourned on account of your want of system and punctuality he will have been put to much avoidable inconvenience. You know that we have an overcrowded

legal profession, that cases in which legal aid is resorted to are on the increase and, that officials are being watched with a more and more critical eye. Therefore it is incumbent on you to see that side by side with enforcing the law you are anxious to cause the minimum hardship to the people, at least to the poorer classes. This attitude on your part adds dignity and prestige to the administration, and it is the duty of all officials, high and low, to create the impression that in their official dealings they are actuated by the highest of motives. I have ventured to make these observations as the Forest Department has been blamed much in the past and still is not considered a blessing though wrongly so at least by some people. In a word do the right thing leaving clamour coldly alone.

Gentlemen, I wish you the best of luck in your career."

(*Madras Forest College Magazine, June, 1930.*)

THE REAL AFRICA—II.

By Julian Huxley.

Up betimes and off across the plains to Machakos, lying among the distant blue hills in the Wakamba country.

The hills are of a fantastic beauty, for instead of green or withered brown they show red, violet, chestnut, purple. But this beauty is a beauty of death. The brilliant colour is the colour of the earth's flesh that should be hidden. Not only is there scarcely a blade or grass on the slopes, but over large tracts the soil has been swept away, and the subsoil or the bare rock itself lies naked to the sky.

This is all due to tree-felling and over-grazing. Not many centuries back, these hills were green with forest. As new migrations flooded the land with their black and brown human waves, new peoples penetrated the hills, hunting gave place to agriculture, and the forest was burned and cut from the plains upwards until only a few scattered grove and sacred trees remained. But grass sprang up where the trees had grown before and the hills were still green, though grazed by thousands of cattle. But after the coming of the white man conditions again changed. Now there were not longer any raids, so that the population, both human and bovine, increased. The tribe was restricted to a definite Reserve, much of which is not suitable for cattle owing to tick-bone disease. They could no longer ease pressure by migration, nor was presure automatically eased by the raids of warlike neighbours such as the Masai. Yet the immemorial attitude towards cattle has changed less among the Wakamba even than in other tribes; cattle for them are still the emblem of social success, the only desirable form of wealth. A settler who has lived for many years on the borders of the Wakamba reserve told me how once an old man of the tribe, whom he had asked why his compatriots refused to sell their beasts or to cull out the poor stock, replied: "Well, you see, we old men like to get

a little drunk and sit about and tell each other how many cattle we've got." Where there is no possibility of talking about your score at golf, your latest car, or your distinguished friends, this is perhaps as good a pastime for the old as any other; but, unfortunately, it is helping to ruin the tribe.

The carrying capacity of the reserve was exceeded, the grass was eaten down here and there, the browsing pressure of the herds of cattle was concentrated on what was left creating a vicious circle, until the soil was exposed without its protecting blanket of herbage, and in many places was washed away down to the naked rock beneath. A recent estimate put the stock carrying capacity of the reserve at 60,000 head of cattle; there are now on it 240,000 cattle, not to mention over a quarter of a million goats!

The immediate misery is bad enough; the mischief done to the land is even more serious. It is easy enough to set erosion going. But once started it will continue at an increasing velocity; it is much harder to restore soil once it has been washed away. Two things seem urgent—to reduce the cattle to reasonable numbers; and to proceed with a broadly-conceived plan of afforestation to temper the violent run-off down the slopes and give the grass a new chance. Forestry is beginning. The native councils themselves are planting trees in the valleys; but this is mainly for wood. The Forestry Department has begun a scheme of planting the tops and water sheds. But this is being hindered by the suspicions of the natives, who regard this as a Government dodge to filch land from them; so do harsh land policies come home to roost!

The Wakamba demand more land as a remedy, and in default of a formal grant are erupting from the Reserve into various stretches of Crown land and into other Native Reserves, naturally creating unrest and disorder. But new land, even if much were available, would be no remedy: it too, in a decade or so, would become over-grazed and generally ruined. The Agricultural Commission recommends the establishment of a meat-factory, to be run at a loss if need be for a time, until the danger is over; and some form of compulsory culling of the stock. Here again, however, the psychology of the "cattle-standard" of economics raises difficulty. Bulls, heifers and steers have different values, as have pound notes, ten-shilling notes and half crowns. But all cattle of one category are equally valuable to the Wakamba, just as all pound notes, new or old, are worth a pound to us. The Mkamba knows that such and such a price is being given for a good working ox; he expects as much money for the wretchedest beast, in the same way as we should be much aggrieved if we were to find the purchasing power of an old dilapidated bank-note only half that of a nice new one.

It really looks as if compulsion—combined, let us hope, with the best kind of propaganda—will be necessary; but it is quite on the cards that it will cause serious discontent. The Agricultural Commission tentatively

suggests that special coins bearing the image of a bull, and pierced to be worn on the person, might be minted for use in the reserve. They would in the first instance be paid over only for stock sold to the meat-factory, and it is suggested that the collection and display of such "cattle-coins" might take the place of the amassing of actual cattle (as baseball has been substituted for head-hunting in parts of the Philippines). It all sounds very Gilbertian; but when the initial situation is so topsy-turvy, perhaps comic remedies will help.

An incident of the afternoon will illustrate the effect of over-grazing on the cattle themselves. I was walking across a hillside with another visitor from England, when a herd of cattle hove in sight. They were so small that I ironically remarked; "Fine goats, aren't they?" My companion, interested in something else, cast a half glance at them, and said with perfect seriousness, "Yes, they're really quite good goats"—a statement which well portrays their size.

Driving back to Nairobi, the Wakamba hills, illuminated by the sunset light, took on the most astonishing colours—red and burnt siena and purple. It was hard to remember that their bright beauty was a beauty of doom and death.

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DURABILITY OF TIMBER.

F. J. POPHAM, F.I.C.

The determination of the comparative durability of timber of various species would not appear to be a particularly difficult business. On the face of it the general method adopted would appear to give all the necessary data. This method, consisting as it does of exposing test sticks to attack under presumably appropriate conditions, would seem to be simple, appropriate, and within a narrow range of error, accurate.

What better test could be devised than to place these test pieces in termite infected ground, in teredo infested waters, in rotting pits or cultures of fungi?

Of the various methods the so-called "graveyard test" so universally adopted may be considered in some detail.

An area of ground is selected as typical of the general nature of the local terrain as possible. Test sticks are placed at reasonable intervals half in and half out of the ground and their behaviour noted at periodic intervals.

This serves as a test against termites, fungal attack and to a lesser extent borer attack.

If the ground is suitably chosen there is no obvious reason why the results obtained should not be comparative and true for the district and for similar districts. It might also be reasonably

assumed that the comparison would be relatively true for other districts although the actual periods might vary.

The test has the merit of excluding seasonal variations and is a sort of weathering test as well.

This method of testing has been in vogue for many years and in many widely distributed areas all over the world. Results given by this test have been and are being recorded both for untreated timber and for timber treated with an antiseptic.

As far as is known, no one appears to have questioned the accuracy of the findings because no one apparently has analysed the results statistically.

There is, however, some reason to believe that the results obtained may not be so comparative as is generally assumed. Analysed results clearly indicate this and on reflection there seems to be some explanation possible.

First of all it is fairly clear that if a species of timber is rapidly destroyed under these conditions it may be assumed to be non-durable. If, on the other hand, it lasts for say 20 years it may be assumed to be extremely durable. There are, however, usually a large number of intermediate values which are subject to considerable variation and a comparative classification of them is doubtful. This variation cannot be accounted for by variation within the species which is known to exist,

When variation occurs, which on the face of it should not exist, the answer probably lies in the variation in the uncontrolled part of the experiment, and the conditions of the experiment are called into question.

To indicate the variation referred to a few examples may be taken as illustrations :—

A small log is cut up into sticks and these are placed in the test ground near to each other and at the same time. All of them are destroyed in 6 months. Clearly a case of non-durability.

Another log of a different species is cut up and similarly treated. One piece is destroyed in 12 months ; two pieces in

24 months; 1 piece in 30 months and the last piece in 36 months. What is the order of durability for this species and why did it vary?

Or again two logs of different species are similarly treated. 80% of the first are destroyed in 12 months and the remaining 20% in 24 months. The second species shows 20% destroyed in 12 months and 80% in 24 months. What is the comparative value of these? The maximum and minimum life are the same but the first is clearly the least durable of the two. If the result is recorded as life from one to two years in each case, a wrong comparison is given. In this particular instance no great harm would be done because the maximum life is low in either case, but it becomes important as the period of durability becomes greater and the divergence wider. In these cases statistical methods may be applied to find the true mean, and this question need not be elaborated here but the illustration will serve to indicate the kind of variations found. Usually an arithmetic mean has been taken and, as is often the case, the arithmetic mean is wrong.

Variations in non-resistant species treated with antiseptics show even greater variations than those given above. Since there are additional variations introduced in the conditions, namely differences of absorption, methods of impregnation, etc., a discussion on these results may be left until later.

What then are the possible variations in the natural conditions which may account for variation not only in the results from one species, but in results from different test grounds and still more important in variations from practice?

When a test ground is started the distribution of termites and nests in the soil is probably normal for the district. At all events it may be assumed to be so.

These conditions are immediately upset as soon as enough test sticks are inserted and the tendency all the time is to concentrate the foodstuff of the termites into a small area. This is probably advantageous at first and there seems good ground for believing that nests and vigorous colonies are established in

the neighbourhood of an assured food supply. The test should, therefore, be an intensive one approaching optimum conditions.

Now the nature of the food supply varies every time fresh sticks are inserted. If, for instance, at any one time the most preferred species of timber has been eaten, the termites will pass to the next desired species.

If at this point a fresh set is inserted, consisting again of most preferred species, the termites will leave the pieces to which they have gone and attack the newly inserted pieces. The rate of attack on the intermediate species will therefore depend on the periodicity of inserting new specimens and on their nature. This periodicity is more or less fortuitous and bears no relation to the rate of feeding or to the concentration of termites in the soil, neither of which is known.

Again the unknown concentration of termites will tend to adjust itself according to the number of specimens in the test ground at any one time but, if the colony becomes too large and the test pieces become depleted for a time, the colony will probably partially migrate. Later when more specimens are inserted some time may elapse before the extra termites return and begin operations. The rate of adding samples is then of considerable importance and this is controlled not by the factor of concentration or by any known habit of the colony but fortuitously by uncontrolled circumstance.

The answer of course lies in a large number of small "graveyards" which can be filled possibly after baiting with a preferred species and then not disturbed except for periodic examinations. This, however, only partly meets the requirements as will be shortly shown.

When a large colony of termites exist, there exists also an abundant supply of termite enemies, who, like the termites, will concentrate around their food supply.

What happens at this stage is problematical. These concentrations of termite enemies may tend to disperse the termites to safer areas, but since the concentration of termites will generally be around the preferred species of timber the concentrations

of termite enemies will tend in the same direction and the termites may be driven to less desired food by reason of the proximity of their enemies to the more preferred species.

Again when some kind of status has been arrived at, new sticks placed in the ground at regular intervals for the sake of uniformity and regularity of examination may very well be placed partly in proximity to a termite enemy concentration and partly away from it. This might account for variation in test sticks of one species of timber.

Clearly these conditions will have to be studied and allowed for and a new technique developed. The present idea is to form isolated and as far as possible protected colonies of termites, much as one isolates a pure culture of fungus for toxicity tests. It will not be easy; but until some method of control is devised "graveyard" tests will always be doubtful and will not correlate with experience.

These objections are not fanciful. It is known that teredo will not attack a heavily creosoted pile if there are uncreosoted piles in the neighbourhood but they will attack if there is no alternative food.

An examination of some fifty results fails to give a factor for multiplying "graveyard" results to practical results. The result varies from 1 to 2½ and this factor is obviously too far apart. It means that if a "graveyard" result gives a median average of 2 years all we can say to an enquirer for practical results is that this species may last from 2 to 5 years. This cannot be called very satisfactory.

With these variations in one district one can easily surmise that the variations in different districts may be considerable and one can deduce from the known variations in one species that probably species, obtained from different districts and tested outside their area, may easily vary much more. This also is a point worthy of verification and decentralised test areas are necessary, placed within the range of the economic exploitation for the species. In this connection it may be noted that two

different observers some two thousand miles apart have placed *Terminalia tomentosa* as more durable than *Tectona grandis*, a result contrary to experience and explicable only on the assumption that the species were tested out of their appropriate area or obtained from sources outside the usual sources of durable teak.

With regard to the durability of treated timber one might expect more uniform results, because it might be supposed that the treatment gave a measure of durability so much in excess of that of the species untreated that the life of the latter was more or less negligible.

This, however, is not the case and the results obtained are even more variable.

Different preservatives behave differently with different timbers and it is difficult to obtain a preservation factor with any degree of accuracy. Three preservatives may be graded A, B and C with one species, B C A with another, C A B with another and so on. Moreover the difference between A B and C, C B and A, etc., may vary. With one species preservative A may be twice as good as B and four times as good as C. With another species B may be equal to C and twice as good as A and so on through all the various combinations.

This is introducing a rather different question but various fallacies may be stated and eliminated here, one may hope for all time.

It has been customary to take what is known as a preservation ratio, that is the ratio of the treated life to the untreated life; sometimes the ratio of the treated life to the difference of the treated and untreated life.

This is shown to be utterly misleading by a homely example.

If two people are playing a hundred up at billiards and the score stands 80 – 40, the loser might like to call this 40 – 20 or even 2 – 1 but the leader would have something to say about it. It is also clear that the leader is in a better position at 80 – 40 than he was at 40 – 20 but the ratio is the same, whether the ratio is

taken as between the highest and lowest or between the highest and the difference between highest and lowest.

The obvious comparative figure to take is the difference between treated and untreated life. In other words if a species will last 4 years untreated and 10 years treated the improvement effected is clearly 6 years. This is as near as one can get but even this is not accurate. It does not follow that if the same preservative were applied in the same way both qualitatively and quantitatively to another species, whose untreated life was 6 years, then the life of the treated species would be 12 years.

The reason is this. A certain minimum of preservative is required to effect preservation. Anything below this minimum will delay attack but not eliminate it. The preservative does not remain unchanged in the wood for an indefinite period but is either leached out or slowly evaporates. When the reduction reaches the minimum necessary for complete preservation, a period of delayed decay sets in, until the amount of preservative left is so small that normal decay results. The difference in life of the untreated control and the life of the treated piece is therefore made up of a period of no attack, a period of delayed attack varying over a wide range, followed by a period of nearly normal attack. The difference between the life untreated and the life treated will therefore be made up of the period of no attack and the period of delayed attack. This latter will be prolonged in the case of the more durable species and shortest in the case of the non-durable species.

A further factor intervenes in so far that it is difficult to treat two species in the same way with two different preservatives, due to the widely different nature of the structure of the species. These variables, in addition to the variables noted in the foregoing in relation to untreated durability tests, are enough to indicate that the "graveyard" tests can only serve to eliminate the unfit and to emphasise the excellent, but that they leave the intermediate rather undefined. For the latter a test under working conditions on the site intended for use is still the only satisfactory test.

ROYALTY REALISED ON CHIL (PINUS LONGIFOLIA) SLEEPERS SUPPLIED TO N. W. RAILWAY.

BY RAM NATH KASHYAP, P.F.S.

The Punjab Forest Department has agreed to supply annually 30,000 *chil* sleepers, obtained from Rawalpindi forests, to the N. W. Railway @ Rs. 3-8-0 each f.o.r. Jhelum.

From the last supply made during March and April, the following figures have been collected, and are likely to prove interesting to those engaged in *chil* forests.

At the time of supply, I had 13,838 sleepers of 9′ × 10″ × 5″ and the passing began with a rejection of 85%. Thanks to the investigation of the Research Institute, the Railway authorities accepted their conclusion that sapwood, when treated with a mixture of creosote and earth oil, is as lasting as heartwood, and rejections on that score were therefore given up. Passing finally resulted in a rejection of 60 %; and 5,502 were accepted.

Sale proceeds realized for 13,838 sleepers amounted to Rs. 36,743-5-0 as detailed below :—

Supplied to N. W. Ry;	5,562 @ 3-8-0 each		19,467	0	0
Sold by auction to public ...	... 6,146 @ 2-3-0	,,	13,444	6	0
Ditto	1,369 @ 2-0-0	,,	2,738	0	0
Ditto	761 @ 1-7-0	,,	1,093	15	0
Total	... 13,838 sleepers		Rs. 36,743	5	0

Cost of 13,838 sleepers extracted departmentally @ Rs. 2-2-0 each amounted to Rs. 29,384-8-0.

Particulars of Rs. 2-2-0 per sleeper are:—

Felling of trees, logging and sawing	per sleeper	... 9·092 annas.
Loss on food godown	per sleeper	... 0·611 annas.
Carriage to launching depôt	per sleeper	.. 13·000 annas.
Floating, collection and rafting	per sleeper	... 3·900 annas.
Landing and lining in sale depôt	per sleeper	... 1·060 annas.
Establishment charges	per sleeper	... 3·370 annas.
Miscellaneous	per sleeper	... 1·451 annas.
Loss in transit	per sleeper	... 1·657 annas.
Total per sleeper or Rs. 2-2-0 per sleeper		... 34·141 annas.

Thus the royalty on 13,838 sleepers = 41,514 c.ft. comes to Rs. 7,358-13-0 or Re. 0-2-10 a c.ft. which is slightly better as compared with the price per cubic foot of sawn timber realised from the sale of standing trees. The Divisional Forest Officer, Rawalpindi East, has very kindly supplied the following figures :—

(*a*) On an average 19 broad gauge sleepers = 59 c.ft. are worked out from a first class chir tree.

(*b*) Standing first class trees fetch Rs. 6 each on an average which means 1·6 annas a c.ft. of sawn timber.

Personally I am inclined to believe that much better prices were realised for standing trees about 20 years back when departmental working had not been started.

DESCRIPTION OF WEST KHANDESH FOREST DIVISION.

By J. A. Singh, I.F.S.

Situation.

West Khandesh District is split up into two Forest Divisions North and West, West Khandesh Division being situated to the south of the Tapti River. It is bounded on the north by the River Tapti, to the east by East Khandesh Collectorate, to the south by the Nasik Collectorate and to the west by Surat Dangs and Gaikwar State. This Division covers an area of 764 square miles and has 6 Ranges. A branch Railway, called the Tapti Valley Railway of the Bombay Baroda and Central India Railway, runs from west to east through the Division. This Railway, which starts from Surat, traverses the most important and valuable jungle tract of this Division and serves a line of communication for the transport of timber to different markets. This railway joins the G. I. P. main line at Jalgaon.

Climate.

The average rainfall in the east is 17″ increasing to 37″ in the west. The temperature varies in the eastern and western portions from 111° F to 109° F respectively. The climate is bracing in Dhulia and in Sakri during the winter months *i.e.*,

November to January, but in the Navapur, Nandurbar, Chinchpada and Pimpalner Ranges, it is extremely malarious, so much so that the subordinates stationed there get a 'Bad climate allowance'. Hot dry winds begin to blow from March till the break of the monsoon and are troublesome. Climatically therefore this Division is certainly not attractive.

Geology.

The underlying rock is basaltic trap with a concurrence of felspar, quartz and hornblende. The soil in the south is greyish black loam, combined with considerable quantities of loose stones and boulders of varying sizes. In the north, black cotton soil of great depth and fertility is met with and it is in such localities that good teak is found.

Flora.

The main species are as under:—

1. *Tectona grandis* (*teak*).
2. *Ougeinia dalbergioides* (*tivas*).
3. *Dalbergia latifolia* (*shisham*).
4. *Terminalia tomentosa* (*sadada*).
5. *Acacia Catechu* (*khair*).
6. *Bassia latifolia* (*mhowra*).
7. *Hardwickia binata* (*anjan*).
8. *Butea frondosa* (*palas*).
9. *Schleichera trijuga* (*kusum*).

The first five are of great economic importance and are always sought after by contractors. *Mhowra* is a tree of vital importance to the local aboriginal tribe, called the Bhils, as they utilize the flowers for distilling liquor, illicitly of course, and the fruit for extracting an oil which they use as a substitute for *ghee* (clarified butter) for cooking purposes. It is also said that the Bhils mix *mhowra* flowers with some kind of flour and make *chappaties* which they very much relish. *Palas* and *kusum* have not attained the importance that they have attained elsewhere as a successful host for *Tachardia lacca*. Many attempts to propagate lac on these species have proved abortive. *Anjan* is of

vital importance to the agriculturists and milk sellers, as the leaves of the tree provide a wholesome feed for the cattle which increases the milk and its fat content.

System of management.

This Division has both organised and unorganised forests. The unorganised areas are in Sakri and Dhulia Talukas and serve as a feeding ground for the herds of sheep and goats owned by the Thilaris and the Dhangars. They utilize the area only during the monsoon months and migrate to the river side in dry weather as both water and fodder are comparatively abundant there. The organised forests are under sanctioned working plans. There are 5 working plans as under :—

1. Dhulia *Anjan* Working Plan which deals with *anjan* areas in Dhulia and Sakri Talukas.

2. Navapur-Nandurbar Working Plan which deals with valuable teak areas in Navapur and part of Nandurbar Talukas.

3. Deomogra Working Plan which deals with a compact area of the forest called the Deomogra Reserve.

4. The Umarpata Working Plan which deals with the Umarpata forest.

5. Fuel Working Plan which deals with scrubby growth in Nandurbar Range which is only fit for fuel.

Of all these the Navapur-Nandurbar Working Plan is the most important and the clear felling with artificial regeneration is the system adopted. The contractor fells the coupe, removes the timber and other material which he can dispose of in the market and the rest he heaps up in patches 50′ × 50′ or more, called *rabs*, which are burnt in the latter part of May and sown up just preceding the monsoon with weathered teak and other seed. The growth of teak on such patches is exceedingly satisfactory and the weeds which are natural enemies of the young plant are reduced to the minimum due to the thorough sterilisation of the soil brought about by *rab* burning. The other working plans are mainly based on the system of 'Improvement felling.'

Shikar.

Shikar is plentiful and the best time for shooting is from March to the advent of the monsoon. During this period water becomes scarce and the wild animals retire to the jungles where some water is available. Tiger, panther, and sambhar are quite common in Navapur and Chinchpada Ranges and a shikari with any luck is not likely to go away disappointed. Fishing in the Tapti is good and mugger are plentiful. From a shikar point of view this Division is quite good and a visit on that score is always fruitful.

No description of the Division can be complete without a brief mention of the indigenous inhabitants of the locality. They are a set of primitive people called the Bhils. The soil presents them with no pleasure in life beyond shikar in the forest and the distillation of liquor from the *mhowra* flowers both of which are done illicitly. They use primitive weapons such as bows and arrows and spears and feel quite at home in the jungle with these weapons. Their women folk are very scantily dressed, and though their love of clothes does not appear to be excessive their love for wearing necklaces of stone beads round their neck is boundless. The story goes that a necklace is added every birthday and therefore woe betide those who are destined to live long. The men are lazy and the contractor therefore cannot depend on them for the completion of the work and has, therefore, to import labour from Gujarat and other places.

THE OPENING OF THE INDIAN ROUND TABLE CONFERENCE, HOUSE OF LORDS, NOVEMBER 12TH, 1930.

BY ONE WHO WAS THERE.

As Big Ben struck the first note of twelve o'clock the King began his speech from the small platform where his chair with a gold crown stood. The speech lasted six minutes and His Majesty left immediately. Every word spoken by the King and by the others who spoke was heard most distinctly from the long gilt loud-speakers which hung from the ceiling.

The speech was broadcast all over the world. After His Majesty had left the gold chair was removed and Mr. Ramsay MacDonald occupied an ordinary leather chair which was put in its place. The speeches have already been published in full. The Royal Gallery of the House of Lords is a very handsome apartment, the ceiling and walls being entirely covered with carving and gold. Two large tapestries occupy the long walls, depicting naval and military scenes and large pictures of King Edward and King George and their Queens hang on the end walls. Each of the four lofty doors is guarded by large gilt statues of Richard Coer de Lion and other famous Kings. Some five hundred people were present including all the most important British politicians, retired Governors of Indian provinces, notable Indians, and many ladies, as well as the delegates. On the King's right sat the Chiefs, the Maharajas of Alwar, Baroda, Bhopal, Bikaner, etc., in alphabetical order. All were in morning dress except the Indians who mostly wore gayer colours. The whole ceremony was extremely well-arranged and impressive and was brief.

A. R.

WORK AMONG ELEPHANTS—SOME SUGGESTIONS.

BY R. S. GOVINDASWAMY, VETERINARY ASSISTANT SURGEON, TELLICHERY.

I.—Indigestion and Diarrhœa.

I was attached to the Forest Department at Nilambur as Assistant Veterinary Inspector for a period of two years and was then in charge of 36 elephants and 26 buffaloes. The experience that I have gained in the management and working of elephants, particularly in treating them for such diseases as indigestion and diarrhœa, I am recording in this article to make it available for others and to invite discussion.

The Veterinary Assistant Surgeon in the Forest Department is responsible for the feeding of animals, their health and for the sanitation of the camp, in addition to treating them for disease, and, as one who has worked for some years with elephants, I may be excused for recording my experiences, however common place they may be, as it will probably invite criticism from those better acquainted with them.

Elephants are less prone to attacks of disease than are domesticated animals, probably because they are not taken away from their natural environment. They work and live in the forests side by side with wild elephants on the same soil and fodder. The following table shows the diseases of elephants treated during 1928-29 :—

Diseases of elephants.

Year.	Wounds.	Galls.	Indigestion or diarrhœa.	Other diseases.	Internal diseases.	Total
1927-28 ...	14	16	40	11	2	83
1928-29 ...	42	19	35	20	7	123

Other diseases include eye diseases, sprains, inflammation, abscesses and musth (musth is not a disease. It is only a physiological alteration).

From the above table it will be seen that cases of indigestion and diarrhœa are most common. The diagnosis of indigestion and diarrhœa is very simple. When the dung is dark coloured and hard it is indigestion ; when loose it is diarrhœa. The treatment, according to circulars, is Ammonium chloride, Potass nitrus, and soda bicarb for indigestion and Crete preparata and pulvis gentian for diarrhœa. Elephants are so valuable that one cannot afford to try experiments in treatment and I was, therefore, content to follow the line of treatment already in use. At the end of a year I was surprised to find that not a single animal escaped such attacks and some suffered more than once, even though the food and sanitary conditions were satisfactory to the best of my knowledge. A study of the case register for the previous five years also revealed the fact that almost every animal suffered from indigestion and diarrhœa year by year.

Wild elephants also pass dark coloured hard or loose dung and I am told that loose dung, with worms, is sometimes dropped by wild elephants also. I have myself seen freshly dropped loose dung of a wild elephant containing round worms, 1½ to 2

inches long. (*Ascarislonchoptera.*) On my way to inspect Donald at Nellikutta, I saw this kind of dung and it occurred to me that this condition must be natural with all elephants. I talked to the elephant-man about this and I learnt that the animals eat mud before getting diarrhœa and that it can be said for certain when an animal will get indigestion or diarrhœa. All on a sudden some animals will refuse food, partly or wholly, without any apparent cause, while dung, temperature and everything else are normal. It will confuse a beginner, but experience will show that is how an animal behaves just before getting diarrhœa. If you examine the dung of such an animal the next morning it is either loose or hard, or dark coated and worms may or may not be present. When an elephant refuses food, if you let it loose instead of sending it for work and if you follow it into the forest, you will notice that it eats the bark of *Miliusa velutina* "*kana kytha*" in Malayanam, or the bark of *Macaranga Roxburghii* (*podu anni*) or the bark of *Careya arborea* (*pezhu*), or *Terminalia tomentosa* (*karimarudu*) or a kind of dark coloured, moist mud resembling that of a crushed ant-hill. If these barks are cut and given to the elephants at normal times they never touch them. There is little doubt that elephants select their own purgatives by natural instinct whenever there is irritation in their stomachs and thereby try to get rid of the irritating matter. A few of the worms that may loose their hold on the intestinal wall pass along with the dung. Again when the animals newly calve their milk supply is poor. If they are let free in the forest, when the calves are able to accompany the mother, it has been found that their milk supply increases on account of their eating something in the forest guided by their instinct.

Indigestion or diarrhœa in elephants is not a serious matter, even if regarded as diseases. Invariably they are cured in 3 or 4 days whether medicines are given or not. Complete rest from work, with holding of grain food and allowing them to graze in the forest will be sufficient when the dung is not normal.

Work of Elephants.

Elephants are by conformation said to be beasts of burden, but they have to go in draught if they are to be useful in forest

work. They are of great value from the point of their capacity for work but it is very difficult to lay down any hard and fast rule as to the amount of work an elephant can do. In the Forest Department, the Inspector of Live Stock fixes the working capacity of each elephant, the height being taken as the principal basis for determining this, according to the following table:—

6′ 9″	...	...	...	25 c.ft.
7′	...	...	...	30 c.ft.
7′ 3″	...	...	...	35 c.ft.
7′ 6″	...	...	...	40 c.ft.
7′ 9″	...	...	...	45 c.ft.
8′	...	...	...	50 c.ft.
8′ 3″	...	...	...	55 c.ft.
8′ 6″	...	...	...	60 c.ft.
8′ 9″	...	...	...	65 c.ft.
9′	...	...	...	70 c.ft.

It is one of the duties of the Assistant Veterinary Inspector to see that this prescription is strictly adhered to and it is here that sometimes the Assistant Veterinary Inspector, who is concerned with the health of the animals, and the Forest Officer, who is responsible for the work, come into conflict. The difficulties of the Forest Officer are many. He is responsible for the outturn of work and is always anxious to finish a given work as early as possible with the help of the elephants. He is inclined to question the correctness of the working capacity prescribed according to height, when for instance elephants like Frank, Thebow and Moulabaksh can almost run with logs of 65, 45 and 40 c.ft. respectively. It is true that to overwork an animal is cruelty, but to underwork it is false economy. It is, therefore, necessary to have a correct idea of each animal's capability. If the maximum capacity of an animal can be ascertained, then a proper prescription of work can be given, allowing a margin wherever necessary and there will then be no question of overwork or underwork. Age in respect of captured animals and conformation are invariably matters of opinion. I am of the opinion that we can gauge the strength of an animal better from its weight than from its height.

In the case of cattle for inoculation purposes, the weight is determined by the formula, $\frac{L \times G^2}{300}$ (all in inches), when L stands for length from point of shoulder to point of buttocks, and G for girth, but I do not know if this is applicable to elephants, having had no chance to weigh an animal on a weigh-bridge. Lieut.-Col. G. H. Evans, in his book "Elephants and their diseases," on page 7, has recorded length, girth, and actual weight of some animals, but it is not known how the length was measured. The table as given in the book is reproduced below:—

No.	Sex.	Approximate age.	Height.	Girth.	Length along back.	Length along side.	Weight in lbs.
1	Female	30	7′—8″	11′—2″	10′—8″	7′—10″	6,278
2	,,	20	7′—1″	10′—3″	9′—10″	6′—10″	5,237·75
3	,,	35	8′—3″	11′—3″	10′—9″	7′—7″	6,296·25
4	,,	30 to 35	7′—3″	11′—2″	10′—6″	7′—6″	6,322·5
5	Male	30	8′—4½″	11′—7″	11′—4″	...	6,460·5
6	,,	40	8′—1″	11′—3″	11′—0″	...	5,931·5
7	Female	30	7′—8½″	11′—4″	10′—4″	7′—9″	6,322·5
8	,,	30	7′—8½″	11′—8″	10′—0″	7′—6″	5,748·75

Average height:—7′—9·1″. Average weight:—2 tons 14 cwts. Remarks:—All the animals "In good condition" except No. 6 in poor condition.

For comparison with the above, corresponding figures for Frank, Thebow and Moulabaksh are given in the following table, the weights in this case having been calculated according to the formula:—

Name of elephant.	Sex.	Age.	Height.	Girth.	Length from shoulder to buttock	Weight in lbs.
Frank ...	Male	40	8′—10″	12′—7′	8′—3′	7,857
Thebow ...	,,	51	7′—10″	11′—8′	7′—10′	6,141
Moulabaksh ..	,,	28	6′—8″	11′—2″	7′—6″	5,386

Average height:—7′—9·3.″ Average weight:— 2 tons 16 cwts.

From the above it will be observed that the average weight of an animal *viz.* 2 tons 16 cwts. according to the formula very nearly corresponds with the average weight *ziz.* 2 tons 14 cwts. obtained by Lieut.-Col. Evans by actual weighment of elephants. So I think for all practical purposes the formula can be depended. upon for ascertaining the weight of an elephant.

If it is assumed that 10 c.ft. for every 1,000 lbs. live weight can be prescribed (which may be considered as reasonable for any draught animal, either horse or cattle) then Frank, Thebow and Moulabaksh would be allotted approximately 80, 60 and 50 c.ft. respectively, whereas according to height the corresponding figures are 65, 45 and 40 c.ft. This shows that in these instances the log to be dragged according to weight is slightly larger than that prescribed according to its height. It will thus be of great help to know the actual weight of an elephant year by year to ascertain the state of its health and its working capacity. If there should be any wasting disease it can very easily be discovered and investigated sooner by noting changes in weight than by mere appearance which is very deceptive. The weight of an animal is a sure guide to its working capacity. If the weight of an elephant cannot be known by any other method then it ought to be weighed actually on a weigh-bridge at least once in a year. It may be impracticable to march all elephants to a distant place where there is a weigh-bridge or to hire and bring a weigh-bridge to the elephant camp every year, but to own a weigh-bridge can never be too costly for an establishment like the one at Nilambur.

THE METHOD OF WORK.

The way in which an animal is worked has much to do with its health and longevity. There are two methods by which elephant can be made to drag. One is dragging with harness and the other dragging by mouth. All Government animals drag with harness, the harness consisting of a numdah, two wooden blocks, a back chain, a drag chain, a collar and a coir rope for the girth. The numdah is made of leather, 6 to 8 feet long and 2½ feet broad, stuffed with cocoanut

fibre to serve as a cushion. The wooden blocks are each 16 inches long, 9 inches broad and 5 inches high, and are connected by a string. The back chain is made of iron, about 6 to 8 feet long, with rings on either end. The drag chain is 30 to 35 feet long and has two hooks at the ends. The collar made of iron wrapped up in cocoanut fibre and leather has also hooks at the ends. The numdah is put on the saddle and the two wooden blocks are placed on it on either side of the spine. The back chain is placed on the blocks across so that the two rings rest on the lateral sides of the chest wall. All these are secured to the body by the girth rope. The collar from the front and drag chain from behind are attached to the rings of the back chain by hooks. This completes the harness. The cost of a new harness and its upkeep may amount to Rs. 125 in a year. There is thus not much difference between the harness of an elephant and that of a horse, but the elephant can never boast of a pronounced wide chest like that of a horse which drags a load placed in a carriage. The elephant drags a log lying on the ground by the drag chain which is fixed to the log and the rings of the back chain. The collar presses on the points of the shoulders while the elephant is at work and causes inflammation and abscesses, sometimes making the animal unfit for work for days together. If there is a very big log to be dragged, say of 170 c.ft., 3 or 4 animals are employed to move it but it is not possible to get all the animals to pull together at one and the same time. When the mahouts order the animals to pull, one of them pulls with all its strength and then stops and the others do the same, one after the other until all can pull together. Thus the wooden blocks make impressions on the back owing to the pressure of the back chain, which lies across them and give rise to saddle galls, and by the harness method of dragging the elephant is subjected to pressure on all sides. If there is an obstruction, such as the root of a tree, a stump or a stone, the elephant cannot see it, and if the mahout also does not turn round and see it, the animal must pull and pull until the obstruction is overcome or it has to make several turns before it can avoid it. The elephant, with a log attached at the end of a

log chain behind it, has to walk according to the directions of the mahout but if it could see the log it would avoid such obstructions. Again when working on sloping ground, if the log by chance rolls down, they cannot disentangle themselves and if the chain breaks or the chain hold on the log slips off, there is very great danger. I have known of three instances of this kind, fortunately unattended by injuries.

The other method is dragging by mouth. All that is required for this method is a *Grewia* fibre rope about 6 to 9 feet long, thick at one end and thin at the other. The thin end is tied to the log through the drag hole and the thick end is given to the elephant to hold between its teeth and all except Government animals drag by this method in Malabar. This is a very simple indigenous method. To make a new rope and repair it may cost from Rs. 2 to Rs. 3 per week and it is said that the rope, if put in water every day immediately after use, lasts for 10 or 12 days. It is very interesting to see an elephant dragging logs by this method and it is noticeable that big logs that cannot be dragged by the harness can be dragged in this manner. All the private elephants of Malabar, Cochin, Travancore and some other parts of Northern India are worked by this method. When a heavy log has to be dragged the animal takes a firm grip between its teeth at the thick end of the rope and twists its trunk round the rope and thus gets as good a grip of the load as a man with his fingers. In private forests the ends of the logs are rounded off to avoid obstruction and in addition, the elephant can see for itself any obstacle and avoid it, or lift up the end of the log and place it on the obstacle to make the dragging easier. The importance of this method is that while working on slopes, if the log moves faster than the animal can walk, the animal lets go its grip and escapes all danger. If the fibre rope is found to be weak at any part, the animal feels it, before he applies full force to pull it and gives up the attempt thus avoiding any mishap. A bullock is strong at the neck, a horse at its chest and an elephant at its neck and head. These strong points of the elephant are made use of in this method of dragging and I think this accounts for their dragging heavier logs than is possible

in harness. I have examined about 23 elephants belonging to private owners but found no disease of teeth, even in a single instance. The disadvantage of this method is that the elephant gets disfigured in old age on account of swellings, tumours, etc., on the cheek and legs and so far as appearance of an animal is concerned this method may not compare very favourably with the harness method, but from a practical point of view the former is superior to the latter because much heavier logs can be dragged more easily and with less danger. Caries or injuries to the teeth are more to be feared but if the elephants should suffer from tooth disease or their teeth become unfit for mastication, I am sure the private owners, especially those owning one or two animals, would not stick to this method. The teeth of elephants are peculiar and special in their mode of replacement. Only two teeth as a rule can be seen on each side of the jaw; these being pushed out and replaced by others growing from behind. Lieut.-Col. Evans in his book "Elephants and their diseases", page 66, gives the following description of their method of replacement:—

"The first set of grinders or milk teeth are not shed but are gradually worn away during the time the second set are coming forward; and as soon as the body of the grinders is nearly worn away, the fangs begin to be absorbed. From the end of the second to the beginning of the sixth year the third set come gradually forward as the jaw lengthens, not only to fill up this additional space, but also to supply the place of the second set which during the same period have gradually worn away and have their fangs absorbed. From the beginning of the sixth to the end of the ninth year the fourth set of grinders come forward to supply the gradual waste of the third set. In this manner to the end of life, the elephant obtains a set of new teeth as the old ones become unfit for the mastication of his food."

To summarise:—The disadvantages of the harness method are:—

1. The harness causes injury to the animal. *Inflammation* and abscess and saddle galls are quite common,

2. The animal is strained at the shoulders and back which are not its strongest parts.
3. The animal is handicapped, being unable to see the log that is being dragged.
4. There is serious risks while working on slopes.

As against these the method of dragging by mouth has the following advantages :—

1. Comparative freedom from bodily injuries.
2. It exercises the strongest parts of the elephant *viz.*, the head and neck.
3. Heavier logs are pulled and more work is turned out.
4. The animal is able to use its intelligence in overcoming obstacles.
5. There is little risk even when working on slopes.

It is claimed that elephants that drag by mouth live longer than those that work by the harness method and I do not think there would be any harm if an experiment were to be made selecting some elephants to work by the mouth and an equal number to work by harness. The difference in the cost incurred, time taken to finish a given work and weight added or lost, etc. can be easily ascertained by maintaining proper records. This experiment is worth trying.

The facts noted above and the suggestions I have ventured to offer are the result of my observations during my short experience with elephants but my experience is confined to elephant work in the Nilambur forest and this article is published in the hope that others with wider experience may be tempted to offer their criticism and suggestions.

FAUNA OF BRITISH INDIA, BIRDS, VOLUME VII, 2nd EDITION.

BY STUART BAKER—1930.

This volume contains a synonymy of all the genera, species and subspecies included in volumes I to V and a few of those in volume VI. There will be a final eighth volume which will contain the rest of the synonymy together with corrigenda, addenda

and an index. We are told that the addenda will contain 54 species and subspecies, of which no fewer than 33 will be newly described. This affords striking evidence of the active interest which is being taken in the birds of India by many ornithologists to-day, for the addenda will be mainly due to the labours of men such as Ticehurst, Whistler, B. B. Osmaston, Meinertzhagen, Wait, Robinson, Kloss and La Touche.

A. E. O.

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TEAK ABNORMALITIES.

BY H. G. CHAMPION, I.F.S., SILVICULTURIST.

The teak plantations raised at the Forest Research Institute in the last 6 years have given opportunities of more detailed examination of the growing plants than is ordinarily possible, and a number of abnormalities has been found and kept under observation for varying short periods. It is obvious that these freaks are of no practical importance to those responsible for raising teak plantations, but they have some significance on broader biological grounds and may be of general interest.

Most of the forms to be described are abnormal in respect of the arrangement of the leaves on the stem in that the very pronounced decussate arrangement of pairs of opposite leaves in four ranks is departed from in varying degree. That such variations are liable to occur among opposite leaved plants has of course been known from quite early times; reference to the earlier part of the chapter on Monstrosities in Hugo De Vries' *Species and Varieties, Their Origin by Mutation* (English Translation, 2nd Edition, p. 400 *et seq*. 1906) will suffice. Examples must certainly have been seen by many officers working in our teak divisions as they seem to occur in most cultures of any extent, and it is probable that were natural seedlings examined as closely, similar variations would be encountered even if in smaller numbers. It is interesting to note that already in Vol. V, 1880,

of the "Indian Forester," a Central Provinces example with alternate leaves is reported and figured ; it was found in a sowing in the Telenkheri gardens at Nagpur, and the occasional occurrence of similar plants in Ahiri (S. Chanda) is mentioned.

The types of abnormality encountered may be classified as follows:—

I. Disproportionately small development of the internodes. Fig. 1. (Plate 2.)

II. Leaves ternately whorled. Fig. 2. (Plate 3.)

III. Leaves normal but alternate and spirally arranged, the stem remaining straight. Fig. 3. (Plate 4.)

IV. Leaves normal but alternate and bifarious, the stem becoming zigzag. Fig. 4. (Plate 5.)

V. Leaves alternate, some at least appearing as though derived from fusion of two leaves. Fig. 5. (Plate 6.)

VI. Leaves mostly normal, but one or more pairs fused together. Fig. 6. (Plate 7.)

VII. Leaves more or less divided.

Type I may be referred to as the *cabbage* form.

Attention was first drawn to it in 1928 by Mr. Pant, and in 1929 as many as eight examples were found (out of about 15,000 plants) though the abnormality was not quite so pronounced in all as in the one illustrated in Fig. 1. It will be seen that the leaves are full sized, sometimes even larger than in the neighbouring plants, but the internodes, instead of being 9″ – 18″ long, only extend to 2″ – 3″. The result must undoubtedly be a marked loss in efficiency of the carbon assimilation mechanism, as in each rank each leaf shades the one below it to a very considerable extent. The eight plants were kept under observation with a view to seeing whether the unusual growth form would persist or not. Unfortunately five were killed by frost and had to be cut back : the new shoot of the following season was in all cases normal. The other three were not actually cut back but no appreciable further development took place at the top of the affected stem, growth being diverted to new shoots developed near the base; these new shoots were normal. In 1930, eight

new plants of the cabbage type were found, but these have also all been killed back recently so that it will not be possible to determine whether the phenomenon is due to a shoot mutation (in which case it should persist in the subsequent growth from the affected shoot) or to some unexplained temporary cause: it seems unlikely that it can be due to soil conditions in view of its disappearance in all cases from new shoots from the base.

Type II, the *ternate* form, is by no means uncommon and might have been expected to occur. The development of whorls of three leaves in place of the standard pair is of frequent occurrence in opposite leaved species in extra vigorous plants or shoots, and in many genera some species are met with in which it becomes the normal thing (*e.g.*, *Clerodendron* and *Plectranthus*); in fact *Tectona Hamiltoniana* is very ordinarily ternate, as also several of the allied genus *Premna*. In 1929, three examples were found, all in different compartments (of 1 acre each), but all were cut back during the winter and gave normal shoots in 1930. In 1930 three new cases were found all in one compartment but these too have been frosted. A change back to the decussate arrangement was found in one plant which was further interesting in having begun with alternate leaves as in Type III under which it is further described, Fig. 7, (Plate 8). No example has been encountered of whorls of more than three leaves though in the plant just described the first two decussate pairs were so close as to be almost whorled. Just as with the normal decussate arrangement, the members of successive whorls alternate, the phyllotaxis construction leaving changed from normal $2+2$ to normal $3+3$.

Type III, in which the leaves are normal but the phyllotaxis is changed from opposite decussate to alternate spiral, is of special interest as an illustration of reversion to what is believed to have been the original condition, *i.e.*, there are grounds for believing that the spiral arrangement is generally the more primitive form, and that the opposite decussate has developed from it and become fixed. The photograph shews that the leaves are perfectly normal and the stem, though somewhat zigzag, does not significantly diverge from the straight. The

leaves appear well arranged for full use of incident light, but the growing point is more exposed to all forms of injury than when the leaves are in opposite pairs. Only one example was found in 1929 and none in 1930, but one or two others were seen before detailed records were kept. We have an interesting example of a change of type in the case of a plant growing in a nursery bed in Kaunli garden near Dehra Dun. This plant began with at least 4 alternate leaves, it then produced 3 whorls of ternate leaves and finally finished the season's growth with 2 pairs of opposite leaves very close together (Fig. 7).

Type IV has normal leaves arranged alternately in two ranks, differing from Type III only in the last mentioned feature. The example already quoted as recorded from Nagpur belongs here, and a few examples have occurred in the Forest Research Institute plantations, one of which is shewn in Fig. 4. It will be noted that neither the lamina nor the midrib of the leaves shews any trace of double origin, so that it is to be assumed that at the growing point of the stem, only one leaf initial is formed at a time rather than that two initials become fused. In other words the phyllotaxis has slipped from the $2+2$ to the $1+1$ system.

Type V with alternate abnormal leaves is rather more frequent than the two forms last dealt with. In 1929 one example was noted and in 1930 two more, whilst the photograph is of one of two or three 1928 cases. It can be seen that the stem is strongly zigzag. The leaves are more or less 2 ranked, but whilst one rank consists of normal leaves, the leaves in the other are obviously either formed by the fusion in varying degree of two initials, or are tending to twin. The best examples shew 3 or 4 such double leaves in vertical succession. Unfortunately again, no single instance has survived over a winter to enable it to be determined whether the shoot once thus abnormal continues so or reverts to normality.

Type VI is very uncommon, *in fact only one example has* been found so far and is shewn in Plate 7. Here the plant

Photo. by Har Swarup, 2...

Fig. 2. Type II. with ternate leaves. Shoot of 1929 with 6 well-developed whorls of three leaves each.

Fig. 3. Type IV, with alternate leaves spirally arranged throughout. Shoot of 1929.

Fig. 1. Type IV, with bifarious alternate leaves throughout. Shoot of 1928.

Photo. by Har Swarup, October 1928.

Fig. 5. Type V, with bifarious alternate leaves throughout, those on the left being more or less twinned. Shoot of 1928.

Photo. by Ram Swarup, October 1928.

Fig. 6. Type VI, normal except for one pair of leaves. Shoot of 1928.

Photo. by Har Swarup, November [illegible]

Fig. 7. Plant with 4 alternate leaves followed by 3 whorls of three, and at the top, two decussate pairs almost on the same level. The side shoots from the base are normal. Shoot of 1929.

is quite normal except that one pair of leaves is replaced by a partially doubled leaf on one side of the stem. It causes some disturbance of the normal four ranks, but to no great extent.

Type VII with more or less palmately lobed leaves would not call for mention were it not so unusual for teak to vary in this respect. Only one example has been met with hitherto. The plant had been grown from a stump which produced two shoots on both of which all the leaves were nearly symmetrically deeply three lobed, the indentations running right to the midrib, and so giving the central lobe the appearance of a separate stalked leaflet.

Although apparently disconnected, most of these types can be seen to be interrelated except for Type I which need not be discussed further, and Type III which, being probably accidental and of secondary origin, can also be left aside. The ternate Type II and the bifarious Type IV are the result of a change from the normal decussate 2 + 2 leaf arrangement for the comparable still symmetrical arrangements 3 + 3 and 1 + 1 respectively. The striking feature of Type VI is the double nature of the leaves on one side of the stem only, but doubtless the phyllotaxis expert could fit it also into the general system. In this connection reference may be made to the publications on the subject of Dr. A. Church *On the Interpretation of Phenomena of Phyllotaxis*, Botanical Memoirs No. 6, Oxford, 1920, and *On the Relation of Phyllotaxis to Mechanical Laws*, Oxford, 1904.

If anyone who sees this note and comes across similar abnormalities would collect information as to the stability of the various alternate leaved types, and send it to the writer of this note, it would be most welcome. Owing to the almost invariable cutting back of teak shoots by frost in Dehra Dun, it is rare that a shoot can be followed through more than one season.

NEW FOREST, DEHRA DUN.

Dated 10th July, 1931.

A LITTLE KNOWN BURMESE BAMBOO.

BY R. N. PARKER, I.F.S., FOREST BOTANIST.

Gigantochloa apus, Kurz ex Munro in Trans. Linn. Soc., XXVI (1868), p. 126.

Bambusa apus Schultes Syst. VII ii (1830), p. 1353.

Gigantochloa Kurzii Gamble in Ann. Roy. Bot. Gard., Calc., VII (1896), p. 65, t. 56.

Schultes' description of *B. apus* is very detailed but as neither culm-sheaths nor flowers were available it is useless for recognition of the plant. The only value in his description appears to be the vernacular name *bambu-apus* on which the botanical name was based. Kurz (Ind. For. I, p. 344) and Koorders (Exkursions Flora von Java I, p. 174) both mention this bamboo as common in Java but neither saw flowers. Excellent flowering specimens were collected in Buitenzorg by Ottens in 1919 together with culm-sheaths which I have been able to compare with Koorders Nos. 36351b, 37246b and 38583b the only specimens he quotes for *G. apus*.

Gamble and Koorders both seem to have realized that *G. apus* Kurz and *G. Kurzii* Gamble were identical but neither definitely reduces the latter. After seeing the types of *G. Kurzii* and Koorders No. 20717b I have no hesitation in making the reduction.

G. apus has further been confused with *Oxytenanthera nigrociliata* Munro. I have myself identified three gatherings of this species by Parkinson in Burma as *Oxytenanthera nigrociliata*. Koorders (l. c., p. 177) mentions 3 specimens determined by Gamble *Oxytenanthera nigrociliata* and suggests that they are *G. apus*. Of these I have seen one (No. 21228b) and agree with Koorders that it is in reality *G. apus*. Kurz (l. c., p. 336) states that Munro has confounded 3 or 4 distinct species under *Oxytenanthera nigrociliata*. Munro's material is so poor that it is not possible to identify any of it with certainty but I suspect that it represents at least two species and that Zollinger 3934 is *G. apus* and not *O. nigrociliata*.

The generic distinctions between *Gigantochloa* and *Oxytenanthera* are most unsatisfactory as pointed out by Brandis (Ind. Trees, p. 719) who transfers *Gigantochloa macrostachya* Kurz to *Oxytenanthera*, and Gamble (in Koorders Exkursions Flora von Java, p. 177). Kurz (Ind. For. I, 1876, p. 342) unites the two genera under *Gigantochloa* and this seems to me to be the most satisfactory course to take. *G. apus* in its floral characters is an *Oxytenanthera* rather than a *Gigantochloa* but in the field it is a *Gigantochloa.*

In the herbarium I do not think it is possible to separate *G. apus* and *O. nigrociliata* with any certainty except by the culm-sheaths. The general look of the specimens is slightly different but the differences are difficult to express in words. The culm-sheath of *Oxytenanthera nigrociliata* is excellently figured by Gamble in Ann. Roy. Bot. Gard. Calc. VII t. 49 under the synonym *Bambusa auriculata.* The sheath of *Gigantochloa apus* is less well figured under *G. Kurzii* in t. 56. The essential difference is that in *O. nigrociliata* the blade is nearly as wide as the top of the sheath only leaving room for a small rounded auricle, in *G. apus* the blade is distinctly narrower at its base than the top of the sheath which ends in a narrow glabrous band some 2-3 cms. long on either side. This band is only slightly widened at the rounded ends.

Oxytenanthera nigrociliata, the commonest bamboo in Tenasserim, is eminently gregarious on flat ground and at low elevations along streams in the evergreen forests. It is commonly known as *waya* or *wanwe*, less often as *waba* and *wabyauk.*

Gigantochloa apus is found on steep slopes above the level of *waya* scattered singly or in small groups in moist evergreen forest. It is a larger bamboo than *waya* reaching 100 ft. in height or even more and 5½ in. diam. The internodes are up to 2½ ft. long and the walls ⅝ in. thick. The flowering culms are usually leafless with flowering shoots in half whorls, little branched and from 1-4 ft. long. The anthers are purple. The culm-sheaths are usually persistent and rot on the culms, the blade being deciduous. The sheaths and blade on both sides are clothed with black hairs.

It has been collected in Burma as follows:—Parkinson 5090, 5101, 5203 all from Amherst District vern. *wado* or *wapado;* Parker Mergui District 3090 vern. *watho.* It has also been collected by Kerr in Siam. *G. Kurzii* is quoted by Ridley (Fl. Malay Penins. V, p. 261) for the Malay Peninsular but the specimens he quotes are either very poor or not *G. Kurzii.*

A NOTE ON THE VARIATION IN THE CALORIFIC VALUES OF SAPWOOD AND HEARTWOOD OF SOME OF THE INDIAN FUEL WOODS.

BY S. KRISHNA, BIOCHEMIST, AND S. RAMASWAMI, UPPER-GRADE ASSISTANT, MINOR FOREST PRODUCTS, FOREST RESEARCH INSTITUTE.

Perusal of the literature shows that in the determination of the calorific value of woods, it has been customary to examine samples containing both the heartwood and the sapwood, and to interpret the results as representative of the species. This procedure is not safe as both the sapwood and the heartwood are likely to possess different heat values and, as their proportion in a given sample is not always the same, the errors introduced will give faulty results. It has, evidently, been presumed that this difference is either not great or of no importance in actual practice. To determine the order of magnitude of such variations experiments have been performed and it has been found that the difference in the calorific values of the heartwood and sapwood may be as high as 600 Cals. The calorific value of woods is generally about 4,500 Cal. and the methods followed in these determinations are such that an accuracy within one per cent. is easily attainable. It is reasonable, therefore, to say that a difference in the calorific value of greater than $\pm$ 50 Cal. cannot be attributed to experimental errors; consequently a variation of 600 Cal. becomes too high a figure to be ignored from a scientific point of view, especially when the proportion of sapwood and heartwood in a tree is variable. The necessity for determining the calorific values of the heartwood and sapwood separately in fuel woods, therefore, becomes apparent and the following table records a few of these:—

TABLE I.—Determination of the Calorific Values of some of the Indian Woods.

Serial number.	Scientific name.	Locality where found.	Vernacular names.	Trade names.	Description.	Moisture on the air-dry per cent.	Ash on the vacuum-dry per cent.	Calorific Values for Vacuum-dried Materials. B. T. U.	Calorific Values for Vacuum-dried Materials. Calories.	Difference in calorific power between sapwood and heartwood (calories).	Remarks.
1	*Acacia Catechu*	Common in most parts of India and Burma.	*Khair* (Hindi)	Cutch ..	Sapwood ...	14·76	2·26	9047	5026	92	Specimen from Dehra Dun Division.
			Sha (Burma)		Heartwood	13·37	2·41	9212	5118		
2	*Terminalia tomentosa.*	Common throughout India in places ascending to 4000′.	*Sain, Asaina* (Hind.)	Laurel	Sapwood ...	15·47	2·59	8849	4916	167	Specimen from Madras.
					Heartwood	20·83	5·38	9149	5083		
3	*Shorea robusta*	Along the foot of the Himalayas, in Nepal, Assam, Bengal, Bihar and Orissa, Central India and North Madras.	*Sal, Sakhu* (Hind.)	Sal ..	Sapwood ...	8·22	0·47	9128	5071	324	Specimen from Dehra Dun Division.
			Shil (Beng.) *Grugal* (Telgu.)		Heartwood	10·11	0·68	9711	5395		
4	*Sterculia urens*	Dry forests of Northern and Central India, the Deccan and in Burma.	*Gulu, tanaku, karrai* (Hind.)	...	Sapwood ...	8·71	1·31	9227	5126	525	Specimen from Forest Research Institute, Dehra Dun.
			Katira (Garhwal)		Heartwood	6·76	1·64	10,172	5651		

TABLE I.—Determination of the Calorific Values of some of the Indian Woods—(*concld.*)

Serial number.	Scientific name.	Locality where found.	Vernacular names.	Trade names.	Description.	Moisture on the air-dry per cent.	Ash on the vacuum-dry per cent.	Calorific Values for Vacuum-dried Materials: B. T. U.	Calorific Values for Vacuum-dried Materials: Calories.	Difference in calorific power between sap-wood and heartwood (calories).	Remarks
5	*Pinus longifolia*	North West Himalaya.	*Chir*, *Chil* (Hind.).	Chir ...	Sapwood .	6·17	0·39	8906	4948	92	Specimen from Dehra Dun Division.
					Heartwood	5·94	0·45	9072	5040		
6	*Morus alba* ...	Punjab plains, Kashmir, North West Himalaya.	*Tut*, *tutri*, (Hind.).	Mulberry	Sapwood ...	11·03	1·23	8280	4600	267	Do.
					Heartwood	12·60	2·76	8761	4867		
7	*Cedrus Deodara*	North West Himalaya.	Deodar ..	Deodar, Himalayan Cedar.	Sapwood ...	5 63	0·42	9095	5053	425	Specimen from Ranikhet.
					Heartwood	6·59	0·59	9860	5478		
8	*Dalbergia Sissoo*	Sub-Himalayan tract and in outer valleys from the Indus to Assam.	*Sissoo*, *Shisham* (Hind).	Sissoo ...	Sapwood ...	10 56	2·69	8595	4775	281	Specimen from Dehra Dun Division.
					Heartwood	9·93	2·40	9101	5056		
9	*Ougeinia dalbergioides.*	Northern and Central India.	*Sandan* (Hind., *Tewas* (C. P.)	Sandan...	Sapwood ...	10·59	2·32	8600	4778	312	Do
					Heartwood	7·37	1·72	9162	5090		
10	*Tectona grandis*	Peninsulas, India and Burma.	*Sagun* (Hind.) *Tekku* (Tam.) *Kyun* (Burma).	Teak ...	Sapwood ...	10·48	2·38	8766	4870	598	Do.
					Heartwood	10·90	1·21	9842	5468		

In the above table it is clearly shown that heartwoods possess a higher heat value than sapwoods and, this is what may reasonably be expected when it is known that heartwood has in it greater concentration of organic substances such as, tannins, colouring matters, salts of organic acids, etc., which may occur as infiltrations in the cell wall or as deposits within the cell itself. Besides. the effect of the resinous and the volatile deposits is also consider able. *Cedrus Deodara*, for example, is well known to possess volatile oil which is removed by heating.

Cedrus Deodara.	Sapwood calories.	Heartwood calories.
Air dried sample calculated on the zero moisture basis.	5,053	5,478
Above samples, vacuum dried ...	5,102	5,132

These results show that on drying in vacuum, the sapwood of *Cedrus Deodara* has not suffered in any manner, whilst the heartwood has lost some of its heat producing volatile constituents. It is natural to conclude, therefore, that the heartwood in this wood has a higher concentration of volatiles than the sapwood. A more convincing case is that of *Tectona grandis* where the heartwood has been known to possess considerable quantities of organic deposits and if these are removed by suitable solvents, the calorific value is also correspondingly lowered, as shown below:—

Tectona grandis.	Heartwood calories.
Vacuum dried sample	5,468
The above sample after soaking in petrol for 24 hours.	5,282

As a rule, the heartwood in most of the species shows a higher heat value than the sapwood but there are certain species in which the reverse is the case. These species are tabulated on the next page:—

TABLE II.—Heartwood giving lower Calorific Values than Sapwood.

Serial number.	Scientific name.	Locality where found.	Vernacular names.	Trade names.	Description.	Moisture on the air-dry per cent.	Ash on the vacuum-dry per cent.	Calorific Values for Vacuum-dried Materials. B. T. U.	Calorific Values for Vacuum-dried Materials. Calories.	Difference in calorific power between sapwood and heartwood (calories).	Remarks.
1	*Anogeissus latifolia.*	Sub-Himalayan tract from Ravi to Nepal, Central and South India.	*Dhaura, dhauri, bakli* (Hind.) *Dandua* (Mar.) *Dhamora* (C. P.) *Veckali* (Tam.)	Axlewood	Sapwood...	5·40	4·52	8570	4761	392	Specimen from Dehra Dun Division.
					Heartwood	15·52	11·00	7864	4369		
	Grewia tiliæfolia	Indian Peninsula and Ceylon, also in North West India.	*Dhaman pharsa* (Hind.) *Daman* (Mar.) *Emu* (Tam.) *Tara* (Tel.)	Dhaman	Sapwood...	4·82	1·68	9446	5248	166	Specimen from Forest Research Institute, Dehra Dun.
					Heartwood	5·49	3·09	9148	5082		
3	*Lagerstroemia parviflora.*	Sub-Himalayan tract, Assam, Lower Bengal, Central and South India, Upper Burma.	*Dhaura* (Hind.) *Zaungbali* (Burma)	Lendi ...	Sapwood...	17·89	1·14	8813	4896	99	Specimen from Dehra Dun Division.
					Heartwood	18·83	1·84	8635	4797		
4	*Quercus incana*	Himalaya from Indus to Nepal, Shan Hills of Burma.	*Ban, banj,* (Pb. Hind.).	...	Sapwood...	12·37	0·57	8289	4605	116	Specimen from Almora.
					Heartwood	11·91	1·69	8081	4489		

5	*Hardwickia pinnata.*	Western Ghats, from South Kanara to Travancore.	*Kolavu* (Tinnevelly). *Matayen, shunali,* (Mal.).	Piney ...	Sapwood ...	12·07	1·59	9056	5031	68	Specimen—from Coorg.
					Heartwood	11·53	2·42	8933	4963		
6	*Populus euphratica.*	Sind and the Punjab.	*Bahan* (Sind) *Bhan* (Pb.)	Indian poplar.	Sapwood ...	5·68	1·63	8888	4938	71	Specimen from Punjab.
					Heartwood	7·45	2·84	8761	4867		
7	*Acacia leucophloea.*	Punjab, Rajputana, United Provinces, Central Provinces, South India.	*Safed kikar* (Hind.) *Hewar* (Mar.). *Vel-valu* (Tam.) *Bili jali* (Kan.)	...	Sapwood ...	7·81	1·75	8663	4813	34	Specimen from Bombay.
					Heartwood	7·01	2·18	8602	4779		
8	*Bruguiera gymnorhiza.*	Tindal forests of India, Burma and Ceylon	*Kankra* (Beng.) *Thuddu porra* (Tel.). *Sirapu kakandan* (Tamil).	...	Sapwood ...	9·11	1·46	9169	5094	56	Specimen from Bengal.
					Heartwood	9·14	0·81	9068	5038		
9	*Melia Azedarach*	All over India and Burma, but mostly cultivated.	*Bakain* (Hind.) *Mella nim* (C. P.) *Malai vumbu* (Tam.). *Thamaga* (Burma).	Persian lilac	Sapwood ...	9·55	0·80	9068	5038	94	Specimen from Bombay.
					Heartwood	7·97	0·90	8899	4944		
10	*Bischoa javanica.*	All over India and Burma.	*Panida* (Hind.) *Boki* (Mar.) *Thondi* (Tam.).	Bishop wood.	Sapwood ...	8·79	1·22	9452	5251	155	Specimen from Coorg.
					Heartwood	8·24	1·28	9173	5096		

The above results have been arrived at after careful experiments and cannot be attributed to experimental errors or accidents. Explanation for such behaviour is not apparent, since the factors that have been shown to give higher heat values to heartwood do not seem to be responsible for this abnormal variation. A possible explanation for the high calorific value for sapwoods may be found in the manner of storage of reserve materials during certain seasons in the year. "In perennial plants the accumulated material formed during the summer is never wholly consumed in the same season; a large part is accumulated and remains in the plant until the following spring. The renewed activity of early spring and the development of new shoots and leaves occurs at the expense of organic material accumulated in the preceding year. In winter the accumulated material, consisting mainly of oil and starch, fills all the pith, the medullary rays, the cortex and some parts of the xylem" (Plant Physiology by Palladin, edited by Livingston, Second American Edition, page 150).

Another point worthy of consideration is the time of the year when the tree is cut for samples. It is well known that the carbohydrate reserves are at a maximum in autumn and sink to a minimum in early spring. (An Introduction to the Chemistry of Plant Products, by P. Haas and Hill, Vol. 1, p. 63.) And the accumulation of the carbohydrate reserves (starches, etc.,) are found in the wood parenchyma of the sapwood only, though in a few species the corresponding cells of the heartwood have also been known to contain small quantities of starch. A sample of wood cut from a tree when it is full of reserve food will, therefore, give a higher calorific value for the sapwood than for the heartwood. If this were the case, all the species cut from a certain locality, at about the same time of the year should behave identically. But this is found not to be the case. Out of a dozen species received from the same forest division, only one or two have given higher values for the sapwood, whilst in all other cases the heartwood has given the higher results. The seasonal accumulation of the carbohydrate in sapwood does not, therefore, offer a satisfactory solution to the problem. It may be urged

however, that different species, even in the same locality, may have different periods of storage of reserves, but unfortunately no such data are at present available on this point for Indian trees.

A careful study of the structure of the woods (in Table II) has also been made, as it was suspected, that it might throw some light on the problem. Abundant wood parenchyma (including the medullary rays and longitudinal wood parenchyma) are found in all those species having sapwood of higher calorific value. Dr. Brown in his book on " Elementary Manual on Indian Wood Technology," p. 70, remarks that " the parenchyma content of the sapwood varies widely in different trees and it is surprisingly high in some cases. The volume of the medullary rays runs from 2 to 11 per cent. for coniferous woods and as high as 40 per cent. in some of the oaks and this does not take into account the longitudinal parenchyma which is abundant in many dicotyledons (the oaks included)". The parenchyma in sapwood contains living protoplast and one of its main functions is the storage of reserve food materials, mostly carbohydrates. In the heartwood the cells of the wood parenchyma are all dead and their contents have disappeared. As the living parenchyma of the sapwood make up roughly from 3 to 40 per cent. of its bulk as compared to the remaining dead tracheal elements, the amount of food materials stored in the sapwood of trees must necessarily be high and, it is in such species that the sapwood will naturally have a higher calorific value than the heartwood.

It may be mentioned in this connection that there are some species in which, though numerous medullary rays are found to occur, the heartwood still shows a higher calorific value than the sapwood. *Acacia Catechu* is an example of this and here the presence of abundant reserve materials in the parenchyma in the sapwood is more than compensated by the heavy deposit of tannin in the heartwood.

The explanations given above are purely tentative, and the opinion of the forest officers and others interested in the subject will be most welcome.

ARTIFICIAL REGENERATION OF FIRE BURNT AREAS WITH DEODAR IN THE FORESTS OF THE WESTERN HIMALAYAS.

BY KAILASH CHANDRA, FOREST RANGER, PUNJAB FOREST DEPARTMENT.

The incendiary fire of 1921 has devastated most of the valuable Hill Forests of the Punjab. Over several acres there seems to be nothing but dry, standing trees killed by the fire. Many such areas have been fully regenerated by the Forest Department, some are in hand and the regeneration of many is still under contemplation.

Different methods have been adopted in different places and in different localities to restock these areas with deodar, *viz*: —(1) broadcast sowings, (2) patch sowings, (3) transplanting of seedlings raised in nurseries, (4) dibbling, and (5) sowing of deodar seed in lines. Each method has its own advantages and disadvantages and gives its own results.

By far the most economical method is to cut all dry, standing trees and all bushy growth that has sprung up during the last 8 years, over the whole area to be regenerated and leave the stuff lying on the ground for a few days. When this cutting is finished a line about 10—15 feet wide is cleared round the whole area to be regenerated, by throwing the dry, felled trees and cut bushes inside the plot. When this line is quite clear a fire is started and the whole dry stuff lying on the ground is burnt outright; after the fire is extinguished the whole area is hoed up properly so that the ashes may mix with the soil and not be washed away by rain and blown down by storms and winds. When the seed is ready it should be thrown broadcast and buried in the soil with small *kassis*. This, if the seed is good, will give cent per cent success and the seedlings will grow up in close canopy from infancy and there will be the least chance to give long side branches. Such seedlings will waste their whole energy upon height growth. This was done in Bijashal and Balara plantations of the Lower Pabar Forest Range of the Lower Bashahr Forest Division.

In many cases the dry, felled trees are cut into billets, collected in heaps, and burnt, but this increases the creation cost tremendously and the whole forest floor does not burn properly. Consequently it does not become porous and friable and the ashes are not spread over the whole area. In this case the seedlings growing upon the places of the burnt heaps will grow up more vigorously than those growing elsewhere. Thus, uniformity is not obtained among the future crop. If these dry, standing trees are not cut and sowings are done under them, they do a lot of damage to the plantation and mar the growth of young seedlings. The roots of these dry trees do not burn and they bind the soil and make it more stiff for the development of the seedlings. Such dry, standing trees if left are inimical to the future crop, inviting fungus attack, disease and beetle attack and help the destruction of the young regeneration at the time of fire.

Next to this comes transplanting of seedlings raised in nurseries. The seedlings are left in the nurseries for 20 months and then they are transplanted in the forest $5' \times 5'$. This transplanting, if properly done, gives very good results. As the seedlings are evenly distributed over the area, there arises no necessity for doing any cleanings among the seedlings for the next 10—15 years. This method is a bit expensive but gives good results, because the seedlings remain in nurseries for 20 months, they get their taproots fully developed in good soil, they have faced the various factors of the weather for the last 20 months, only seedlings from the best seeds survive and the rest have died in the nursery. This transplanting is done when the monsoon breaks in the first fortnight of July and the seedlings, which have got their root system well developed in the nurseries, have 3 months' rain before them and by the end of September they get fully established. There remain the least chances of mortality and results are quite favourable. This method has proved successful in areas where direct sowings have failed, *e.g.*, Soaribir plantation, Sainj Range of Seraj Division and Kruli plantation of the Lower Pabar Range, Lower Bashahr Division.

This method has proved to be a bit expensive but is most successful and very economical so far as the seed is concerned since there is the least wastage.

Third comes the patch sowing which is most commonly used all over, as it is the least expensive to start with. There are a good many disadvantages with this method and the cost of creation may be double of the first two methods, as mentioned above.

Sowings are done in patches in November and December and the seed germinates in the following spring in March and beginning of April in hot and cold localities respectively. The young seedlings have not got their root system fully developed before the hot summer comes along and the young seedlings in most of the patches are killed outright. In the next year the sowings have to be repeated over the same area to fill up blanks. These sowings are repeated for several years to fill up blanks and when all these have failed then comes the turn for transplanting, which makes the area fully regenerated and automatically the cost of creation becomes three to four times that of the first two methods. If by good luck this patch sowing is successful, then comes the question of wastage of seed and expenditure on cleanings, etc. In each patch of $2\frac{1}{2}' \times 1\frac{1}{2}'$ one handful of seed (about 200 in number) is sown. After 2 years the cleaning of the patch is started to avoid congestion of the seedlings. These cleanings continue for the next 10 years and after this only 2 seedlings in each patch are left and the rest have got to be thrown away, which makes a loss of 198 seeds per patch. Only 1 per cent. of the total seed collected is brought into use and 99 per cent. is simply wasted. By adding the cost of clearing of the patches, of the seed wasted and that spent in filling up gaps and blanks, it will amount to much more than the cost of transplanting, etc.

From experience it has been observed that broadcast sowings by burning the whole area and transplanting of seedlings raised in nurseries are the most economical and useful methods which give satisfactory results and these are to be commonly used.

HOSHIARPUR FOREST DIVISION.

BY J. SINGH, I.F.S.

Situation.—Hoshiarpur Forest Division consists of the whole of Hamirpur Tahsil and part of Dehra Tahsil (lying south of the Beas River) of the Kangra District and that part of the Una Tahsil of Hoshiarpur District which lies between Kangra District boundary and the Sohan Khad, and two large bamboo forests in the north-east corner of the Dasuya Tahsil of the same District. The Division is divided into three Ranges :—

(i) Hamirpur with headquarters at Hamirpur which covers the whole of the Hamirpur Tahsil.

(ii) Una Range with headquarters at Bharwain, which includes parts of Una and Dehra Tahsils referred to above, and

(iii) Mukerian Range with headquarters at Pandain which comprises the two large bamboo forests in Dasuya Tahsil. The headquarters of the Division are at Hoshiarpur which is also the headquarters of the Civil District and a terminal Railway Station—25 miles from the Jullundur Cantonment Railway Station on the branch line from Jullundur to Hoshiarpur. Hoshiarpur is only five miles from the foot of the Siwalik hills.

Classes of Forests.—Three classes of forest are met with in the Division :—

		Area.
1.	Reserve	30·30 sq. miles.
2.	Protected	202·97 „
3.	Unclassed Forests	151·85 „

Climate.—The climate is generally healthy, the soil sandy and the water has little or no tendency to stagnate. The average yearly rainfall is 36″ at Hoshiarpur and 55″ at Hamirpur ; of this about 75 per cent. is during the summer and the balance is accounted for by the winter rains.

Generally speaking the temperature is never excessive and the nights in the cold weather are very cold, particularly in the vicinity of river beds.

Topography.—The country ranges in elevation from 900′ to about 4000′ and in configuration from practically flat land to moderate slopes running from the ridge down to the *nalas*. In Una Range the configuration is rather peculiar; from the boundary ridge (boundary of Kangra and Hoshiarpur Districts) the country drops for several hundred feet, and then, when viewed from above, appears to be a table land sloping down gently to Sohan Khad; actually it is a mass of broken hills with tops varying from flat lands to narrow ridges, and cut up by deep ravines.

Hill torrents or "Chos" are special features of the district. These start in the hills below the water shed, leave them by a narrow outlet and widen on their way to the plains until they break into a number of branches. They pour down enormous volumes of water suddenly in the rains and cause considerable damage in the plains at the foot of the hills, by erosion and sand drifts.

Geology.—The geology of the outer Siwaliks can be found in Medlicott's sketch of the geology of the Province. The range consists entirely of vast beds of sand alternating with loam and clay in very small proportion, with extensive beds of loose conglomerate or gravel. The pebbles of these are never very small nor are very large boulders found; they consist of matamorphic and quartzitic gneiss and granite rocks derived from the older Himalayan formations. These beds are the result of aqueous action but the strata so deposited have been upheaved. Most of the strata of sand are very soft.

Flora.—The principal species (trees and shrubs) found in the Division are as follows:—

(i) *Chil* (*Pinus longijolia*).
(ii) Sal (*Shorea robusta*).
(iii) Bamboos (*Dendrocalamus strictus*).
(iv) *Kikar* (*Acacia arabica*).
(v) *Phulah* (*Acacia modesta*).

(vi) *Ber (Zizyphus Jujuba).*
(vii) *Dhak (Butea frondosa).*
(viii) *Kinnu (Diospyros tomentosa).*
(ix) *Garna (Carissa spinarum).*
(x) *Mendru (Dodonæa viscosa).*
(xi) *Raini (Mallotus philippinensis).*

System of Management.—According to the current Working Plan the following Working Circles are distinguished :—

(*i*) *Kangra Pine Working Circle*:—This includes all the *chil* forests of Hamirpur Range. Method of treatment adopted:—Shelterwood Compartment System. Rotation:—120 years with four periodic blocks and 30 years as regeneration period. Yield calculated as $Y = \frac{V + \frac{1}{2}I}{P}$ where V = volume of the first periodic block and I = increment expected during the first period of regeneration, *i.e.*, 30 years or V and P = the period of regeneration. No trouble about getting regeneration if closure is properly enforced. Subsidiary fellings in Periodic Blocks other than Periodic Block I prescribed.

(*ii*) *Hoshiarpur Pine Working Circle*:—This comprises all the *chil* forests of the Una Range. Sal is a minor species in the Circle. Method of treatment is the same as for the Kangra Pine Working Circle. Rotation = 80 years divided into four periods of 20 years each of the four periodic blocks; yield calculated by the same formula as for Kangra Pine Working Circle. Thinnings and Improvement fellings prescribed for Periodic Blocks II—IV; this includes thinnings in the under-storey of sal saplings sprung both from coppice and seed.

(*iii*) *Bamboo Working Circle*:—This includes the two large bamboo forests, *i.e.*, Karanpur and Bindraban of Mukerian Range and Bakarrar in Una Range. Bamboo felled on biennial rotation; Coppice fellings prescribed for Bakarrar for other scrub species.

(*iv*) *Coppice Working Circle:*—This includes the scrub forests in Una Range. Method of treatment prescribed—Coppice with Standards. The rotation is 20 years. Average annual coupes prescribed. In the coupes felled introduction of more valuable species suggested. For want of market prescriptions only insufficiently carried out.

Shikar.—The fauna of the Division presents no peculiar features. Panther, pig, antelope, barking deer, wolves and a large species of wild cat are common. Of game birds, jungle fowl pheasant and chikor are found in Sola Singhi hills and pea-fowl, and grey-partridges are found everywhere. Black partridges are not uncommon. Sand grouse visit the district in their migration and snipe and duck are found during the winter on the rivers and marshes.

The Beas River abounds in fish of various kinds of which the mahasir and rohu are the best. Of the various fishing places Talwara, on the left bank of Beas, which is only 16 miles by a motor road from Mukerian, a terminal station on Jullundur-Mukerian branch of North-Western Railway, is most popular with fishermen. There is a District Board rest-house at Talwara.

CHAMP NURSERY (MICHELIA CHAMPACA).

By T. M. Coffey, I.F.S.

Seed Bed (New).

Cost of collecting and cleaning *champ* seed, making a seed bed, and sowing and tending *ckamp* seedlings in that seed bed until ready for pricking-out.

Data

1. Collecting 2 bags of uncleaned fruit = I cooly @ Re. 1/8/- and I @ -/8/- each = Rs. 2/.
2. 2 such bags yield 2 seers water tested cleaned seed = 26,000 seed.

3. Plant per cent = 30 to 40, say, 35%; *i.e.*, 2 seers cleaned seed = 9,100 seedlings.

4. A seed bed (12′ + 6′) required 2 seers of cleaned seed (sown broadcast).

No.	Details.	Cost.	Remarks.
		Rs. a. p.	
1.	Collecting seed; 2 bags = one cooly @ Re. 1/8/- and one @ -/8/-	2 0 0	
2.	Cleaning 2 bags @ -/8/	1 0 0	Seed wont keep, therefore coolies must be engaged to assist Mali.
3.	Total cost per *Kamra*, *i.e.*, making one new seed bed 12′ × 6′. This will include (a) 3 thorough hoeings 18″ deep each, and breaking up the earth by hand to a fine powder (b) Cutting poles, or bamboos, making frame-work and thatching.	2 0 0	(a) = -/8/- *i.e.*, one cooly (b) = Re. 1/8/- *i.e.*, -/8/- for frame-work and Re. 1 for cutting and carriage of grass and thatching.
4.	Collecting leaf mould from forest, 8 cooly loads @ -/-/6.	0 4 0	Mali does the sieving. 8 cooly loads = 6 sieved loads.
5.	Sowing seed—done by Mali (water immediately after sowing).		Seed covered with a layer of leaf mould, not thicker than its own diameter.
	Therefore cost of 9,100 *Champ* seedlings, ready for pricking-out =	5 4 0	
	Therefore cost of 600, *i.e.*, enough for one pricking-out bed. =	0 5 7	
	Picking out 4″ × 4″ = 648 plants @ $\frac{72 \text{ sq. ft} \times 144}{4 \times 4}$		
	but, the actuals were 600 ,, @ $\frac{24,000}{41 \text{ beds}}$		in Sevoke 1928-29 nursery.

PRICKING-OUT BED (OLD).

Cost of preparing an old bed, pricking-out in same and tending until transplanting. It is considered fair to charge for old pricking-out beds as new seed-beds have been charged for.

No.	Details.	Cost Plains.	Remarks.
		Rs. a. p.	
1	Preparing old bed, 12′×6′:— Hoeing 18′ deep, breaking up the soil, repairing frame-work and re-roofing (*i.e* thatching). 2 coolies @ -/8/- each.	1 0 0	This includes cutting, carriage and fixing necessary poles or bamboos; also cutting and carriage of grass.
2	Pricking-out 4″×4″ (water immediately after pricking-out), 600 seedlings.		Seedlings to be pricked-out by Mali. Prick-out at least 4″×4″ to facilitate transplanting with balls of earth.
3	Tending, based on 1 Mali per 50 beds for 1 year; pay of Mali Rs. 12.	2 14 1	
	Therefore pricking-out bed cost of 600 seedlings. =	3 14 1	
	and seed bed cost of 600 *champ* seedlings =	0 5 7	
	Therefore total cost of 600 *champ* seedlings ready for transplanting =	4 3 8	
	Therefore cost of 1,210 for transplanting one acre 6′ × 6′ =	8 7 4	

EDITORIAL.

"BUY EMPIRE TIMBERS."

The Real Reason why this Patriotic Slogan Fails to Catch On.

By R. R. Rivers.

Again the festive season is with us, and once more the Editor, in that "Peace-on-earth, good-will-towards-men" spirit is taking the risk of letting me run loose in his columns.

The outstanding feature of the past year has been the formation of a United Empire Party, with the object of fostering trade between this country and her dominions. But despite the existence of this Home-Groan Party, as it is known in the trade, there are still no signs of feverish activity in the market of Empire timber, and the old inertia remains.

From this it might be inferred that those engaged in the timber trade are sorely lacking in patriotism. On the contrary, if timber merchants can sell British timber at a greater profit than foreign wood they will sell it. Nor must it be thought that wood consumers generally are not patriotic, and have no desire to use British timber. If they can buy British timber cheaper than foreign wood, they will buy it. Neither must you assume that "Chips" (technical name for carpenter, and no connection with fish)—see *Allnuts' Hoxton Dictionary*, 5s. net—is a less patriotic fellow than his brother workers in other trades, and refuses to work Empire timber.

Why, then, is the demand for Empire timber not greater?

To remove any wrong impression which (no doubt, the iron and other metal merchants will pounce upon with secret glee) I may have created of those in one of the greatest and oldest trades in the world—timber—I will at once say that economics, or profit and loss, have nothing whatever to do with the question.

No! The matter is far deeper; and to find out the real reason for this half-hearted, lukewarm, "afraid-to-try-it" spirit in which British timber is usually approached, one has to delve far into the depths of human psychology. To do this there is no better place than in a London timber yard.

Seeing that everyone at some time in his or her life must make use of a piece of timber, from the old lady who requires a piece of "planking" to make a perch for a canary cage, to the builder who wants a "few sticks" of 8in. × 8in., about 24 feet long, to shore up a building, it is in the timber yard that one encounters every type of humanity. From this vantage point I have closely studied the matter of Empire timber, *and have come to the conclusion that its greatest drawback lies in the* NAMES *given to the different woods!* (Sensation. Gasp for breath at this point.) Let us look at them:

Iroko.	Thitka.	Ainyerań.
White Chuglam.	Pyinma.	Ekhimi.
Crabwood.	Rimu.	Anamomilla
Gurjun.	Ogugu.	Quondong.
Gumhar.	Obobonekhui.	

They get worse as you go down the list. Those above are a few of the woods bearing the most simple names. To type some of the others would require a person possessing two left hands, a disordered mind, and a specially constructed typewriter. Could you expect any material to be a "best seller" with such a handicap? No wonder His Royal Highness the Prince of Wales said our salesmen needed more culture!

Certainly our salesmen will need more culture to cope with Empire timber and, as will be seen on glancing at the names of the woods, the elocution of the City merchants will have to improve, too. (This could be done by spending a day in a timber yard and listening to the staff, paying special attention when a 6-ton lorry load of stuff arrives unexpectedly about ten minutes before closing time.) Also, and this is a more difficult matter, the consumer will need culturing.

'Tis true that everyone uses timber, but it seems to have been forgotten that, generally, only the better-class people enter a timber yard and, owing to their high mentality, some are easily offended. More than one merchant, I hear, has lost customers in an attempt to sell Empire wood, which makes one reflect on the old question: "What's in a name?" This may seem incredible to those who are timber merchants on paper; they who sell timber by the mere issue of a dock order, as distinct from we tough blokes who actually handle the stuff and bear the full force of the consumer's epithets in the yard. Therefore a few instances which have come under my personal notice may enlighten them and, by dragging the matter into the limelight of publicity, may have the effect of inducing the Empire Marketing Board to take immediate action.

Example I.

A few days ago a builder's representative, complete with cap and muffler, entered the yard whistling—as is their wont—and asked for a "six foot o' free by four yaller deal." The young salesman (who had just sent off his subscription to the United Empire Party) replied with a veracity which drew forth admiration from an importer's traveller who happened to be in the yard at the time: "We can supply you with yellow deal, but would prefer you to take a piece of Ana ——, Anom ——, Adam ——, . one minute, I have forgotten the name," and off he ran into the office to find it out. Anamomilla was what he meant. But while he was gone the builder's representative said: "Blimey, wot's up wi' 'im? I can't 'ang about 'ere all die. I'll git it somewhere else." And out of the yard he went. Thus we lost a good sale.

Example II.

This customer was an antique furniture maker by trade—one of the old school: square bowler hat and seam down the outside of trousers, reminding one of Old Hoppus. Strongly against horse-racing and beer money. Being a regular customer he walked straight down the yard, instead of entering the office, and as he approached one could see a wave of self-sacrifice pass over the faces of the porters in pleasant anticipation of some hard work for nothing. He wanted a board of American walnut. Now it happened to be the day of the Cesarewitch, and as the governor was standing about the yard all the salesmen were awake. One of them sprang forward and, trying to be witty though natural in front of the governor, said to the customer: "I can put you on a good thing for to-day, sir. Quondong! Far better than American walnut." The customer turned and walked out of the yard. Later he wrote saying he was sorry to find we combined a tipster's business with that of timber, and that, on principle, he could deal with us no more. Thus ended the second lesson.

The enormous difficulty yardkeepers have in inducing the consumer to try new woods, even when the latter possess quite ordinary names, is common knowledge; but to expect them to sell woods with such diabolical descriptions as those given to most of the Empire variety is like expecting a foreman to admit that it was *his* mistake and not that of the porters. Apart from yardkeepers, there are other respectable members of the trade on whom the nomenclature of Empire timbers falls equally hard.

Example III.

This example is reported from a saw mill. It appears that one of the firm's regular customers for sawdust was, strangely enough, a sausage manufacturer, and I am told that he himself used to come to the mill about twice a week to select the dust he required—usually of American ash or walnut. On his latest visit one of the young sawyers, with commendable patriotism, approached him and said: "Sir, would you like to try some of this dust? It's Chuglam!" "Chuglam!" repeated the customer.

"*Chuglam*! No thanks; I only make the ordinary sausage——" He stopped suddenly, went very red, looked hard at the sawyer and left the mill hurriedly—never to return. I admit it is an exceptional case; but the fact remains that the mill lost a good customer through trying to do the Empire "a good turn," as they say in the highest charing circles.

In order to make certain I was not perjudiced in the matter I sought the opinion of the trade over a wide section, from the porter to the importer, and, with one exception, all were agreed that Empire woods should be re-christened with names one could utter in front of one's family without blushing. The exception was one of those City chaps who splash ink on dock orders—documents such as those on which the names of the ship and port are written in a way which makes the hieroglyphics on Cleopatra's Needle look dead easy to decipher. He chuckled when I mentioned the names of a few Empire woods. "Splendid! Just think, my boy, what a mess we can make on a dock order with such lovely names!" he exclaimed. "When you yard men ask for all the best lengths in a parcel we must get our own back somehow. I think the names are luscious," he went on. "Gumhar! Ogugu!! Rimu!!! Obobonekhui!!!! Ekhimi!!!!! Oh! Do please *tell me more*"; and here he doubled up with glee. I didn't stop to argue with him. He was a silly fellow. Besides, my lunch was *poured* out.

(*Timber Trades Journal.*)

FOREST LIFE AND ADVENTURES IN THE MALAY ARCHIPELAGO.

BY DR. ERIC MJÖBERG. TRANSLATED BY ANNA BARWELL.

Dr. Mjöberg, the Swedish naturalist, spent eight years exploring the tropical forests and mountains of Borneo and other parts of the Dutch East Indies, and this little book gives a popular account of his many adventures, and of the strange animals and plants he met with in places scarcely ever visited by white men.

Borneo has a rich fauna of great and small animals, including the elephant, rhinoceros and buffalo, which last, we read, is the most dangerous of all the big game. The Borneo jungles and forests are the home of the

leopard cat and the Malay bear, but it is not easy, the author says, to understand why the tiger, so common in Sumatra, has disappeared from Borneo. There are immense numbers of orang-utans and monkeys, one of which, the proboscis monkey, with a long nose and bushy side whiskers (figured on plate 16) is a comical caricature of an unintellectual human being. There are flocks of small birds resembling swifts which build nests of glutinous saliva in the caves, and these are in great demand as a delicacy in China. These edible nests are sold for £4 a kilo, and the yearly trade in them amounts to £250,000, we are informed. Certain districts swarm with python snakes and cobras, and the rivers have two species of crocodile; the most common grows to the enormous length of 8½ yards, and is a terrible scourge where it is found.

There are many curiosities, including fish than can walk and climb trees, and frogs that fly, but perhaps the greatest wonder is of a botanical nature. This is the *Rafflesia*, the largest and most remarkable flower on earth, so called after Governor Raffles, the creater of Singapore. The whole plant consists of a single flower without a trace of leaf or stalk. It is a parasite which opens in a night and lies exposed for a week or so, flesh-coloured and striped with snowy white. It grows to a little over a yard in diameter and weighs fully fifteen pounds, but is of no use as a buttonhole specimen, not only on account of its size but because it emits a horrible smell that poisons the air for miles around!

Among the many excellent illustrations of these tropical products and scenes, pictures are given of the rubber trees and of the method of tapping them for the latex out of which the solid rubber is produced. There is a map of Borneo showing the author's expeditions, which were carried out at great risk, and he is to be congratulated on his safe return to civilisation and on the very interesting, instructive, and also entertaining book he has written, the translation of which is very well done.

(*Scottish Geographical Magazine.*)

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REGENERATION OF "IN" (DIPTEROCARPUS TUBERCULATUS), YINKE RESERVE, KATHA DIVISION.

BY R. UNWIN, I.F.S., BURMA.

The following notes have been written in the hope they may be found of interest to officers occupied with the regeneration of sal about which one or two articles have recently appeared in the "Indian Forester". Conclusions reached in Assam that sal regeneration is easy provided grass is present, and that the old fashioned treatment of hacking and burning followed by hacking and burning is adopted, seem to apply equally to *in* in Burma.

The Yinke Reserve includes about 105 sq. miles of flat *in* forest which contains a fair amount of *ingyin* (*Pentacme suavis*) in patches but in which *in* is by far the predominant species. The original Working Plan had for its object conversion into a uniform forest consisting of a series of even aged woods. It started off with two-fifths of the area classed as post regeneration in which the work prescribed consisted of felling remains of the old crop, unsound and damaged stems, combined with clearing and thinning, if necessary, among the young crop. The existing regeneration had its origin in previously unregulated fellings, therefore to some extent concentrated, in the more accessible portions of the forest. It was usually

fairly dense but had an overwood of trees rejected by traders under the license system of extraction.

The Reserve was divided by straight compass lines north and south and east and west into compartments exactly one mile square. No enumeration was done in the post regeneration block which was presumably selected by ocular methods tempered by geographical considerations. Previous felling having been haphazard the forest was not homogeneous and, even in a large area all *mainly* post regeneration type, it would not be possible to select a solid square mile of it. On the other hand while not entirely mature there were large blocks consisting mainly of even aged high forest of large size without much advance growth. As a result classification by units of one square mile was far from satisfactory and one compartment at least, compartment 19, though included in the post regeneration block, was in fact almost entirely over ripe for the axe.

The most important prescription for the block ran as follows :—

> "The main object of felling must be the removal of all mature and unsound trees and of all isolated trees or small groups of trees interfering with the young crop. No girth limit can therefore be fixed."

Had the marking been entrusted to an experienced officer possibly he would have protested! One can only imagine a junior man shuddering at the idea of criticising a plan signed, sealed and delivered by high authorities ; at any rate the above prescription as applied to compartment 19 amounted to practically a clear felling of every marketable stem and before notice was attracted the trees were sold and extraction had begun. This may sound incredible to officers who can get round their division in a motor car and be back to breakfast, but it is not impossible in a division as large as Katha even to-day. Some idea of the mistake (as it was then believed) may be gathered from the fact that 13,000 odd tons of *in*, of royalty value over Rs. 40,000, were extracted from this single square mile of "post regeneration" forest. The Divisional Forest

Officer sat down and wept when he saw it first. He christened the compartment a "forester's nightmare" in which "every known silvicultural offence had been committed." The only remedial measure he could devise was to order retention of about 1000 seed-bearers and to attempt fire protection of half the compartment as an experiment. Fire protection (fortunately as it seems later) failed and within a year or so he was endeavouring unsuccessfully to get someone to buy his 1000 seed-bearers. (They were 6′ girth and under, which is not a marketable size in this reserve.) There were then 2 changes of Divisional Forest Officer in 6 months and, when the writer arrived, nature was taking a hand in removing the seed-bearers by wind free of charge, while a clearing up felling following extraction had just been completed.

The original stand had a fairly thick undergrowth of *thetk* grass (*Imperata*) and practically no visible advance growth on the ground. (The word "visible" is used advisedly as will be seen below.) Owing to the heavy stand extraction took 3 years to complete and in the meantime grass increased enormously. During the period of extraction, and indeed from the beginning, no attempt was made to fire protect so that, what with lop and top and dry grass growing several feet high, there was always a fierce fire after extraction began. It may be mentioned that the whole forest is extremely hot and dry; even the water required by firewatchers has to be carted 5 miles to them. In December 1929 the Conservator of Forests, Northern Circle, and the Silviculturist inspected the compartment and were impressed by the amount of *in* regeneration showing above the grass, *i.e.*, three months after the final clearing up had been carried out. They counted sample areas and found from 3,000 to 5,000 plants per acre standing over, in, and under, grass about 6′ or more high. Considering that these would be killed back by another fire, protection was ordered for 1930 and by dint of extra care, and possibly some luck this was successful. Anything more inflammable than the remains of previous debris, plus an improvement felling of rubbish costing Re. 1 per acre, plus dry grass 6′ high, is difficult to imagine and when the writer first

saw it in January 1930, *i.e.*, after the Conservator's visit he was inclined to disagree, on the ground that it would be safer to burn at least one more year and dispose of the mass of inflammable material thus making it safer for future attempts. Protection was, however, carried out and both grass and *in* benefitted. A year later the *in* has grown 18″ or more on an average and is beginning to get together over the grass. There is little doubt that the original "nightmare" in the course of a few years will be a densely stocked even aged wood of great value.

To sum up, practically clear felling of mature *in* forest *spread over a period of 3 years combined with fierce fires every year* has produced a good crop of young *in*.

The astonishing part of all this is that the regeneration is almost entirely coppice growth and the question arises where were the seedlings before? It is a fact that in neighbouring forest under a mature crop it is exceedingly difficult to find a seedling. 1930 was a bad seed year it is true, but a fairly careful search in different places failed to discover a single true seedling anywhere in the reserve. The dismay of the officer who first saw the fellings was, therefore, justified and was not due to mere careless over-looking of seedlings. So far no proven explanation has been offered but it is suggested that possibly *in* seedlings which germinate under cover have unusually small leaves which they only retain for a very short period. Compared with the leaf of an older plant the leaves of *in* seedlings even in the open are very small. If suppressed seedlings are smaller than usual and only in evidence a short time in the rains, they might easily pass unnoticed unless observed continually. Continued observation has never been possible up till now, but with the advent of a permanent Assistant light should be shed on the matter. It would be interesting to know if any similar phenomenon occurs with sal. At any rate, in the Yinke, clearing of the cover results in the appearance of coppice shoots most of which have been burnt back once or more and which soon become prominent with their large young red leaves.

The thickest crops of young *in* almost anywhere in Burma are found where there has been heavy felling, grazing and hot fires, *e.g.* in unclassed forests near a village or a sawmill, so results in Yinke simply confirm what can be deduced from observation elsewhere. It is interesting to note that plots made by the Silviculturist to determine the best method of regenerating mature *in* forest gave results which agree with experience in Compartment 19. Several methods were tried; seeding felling with or without burning, strip felling, etc., etc., and the records show that the best results were given by wide strips. The wider the strip (and therefore the nearer approach to a clear felling) the better the regeneration!

Our present extraction policy is towards short contracts for local traders and it remains to be seen whether these will really be suitable. It is the writer's opinion that felling by degrees so that debris is burnt 2 or 3 years in succession, aided by working of the soil incidental to felling and logging, etc., plus grazing by contractors' buffaloes, all play their part in inducing regeneration. It may be that complete clearing with only one good burn would not be so successful.

KATHA, BURMA:

Dated 6th February, 1931.

SAL REGENERATION FELLINGS.

By D. Davis, I.F.S., Instructor, Forest College, Dehra Dun.

The problem of sal regeneration has been discussed in such detail during the last few years, and so many articles have appeared in the "Indian Forester," more especially since 1927, that it may be thought that there is little more to be said on the subject at present. I do not propose to propound any startling new theories on the subject, but merely to emphasise one particular aspect of the problem, which appears to me to deserve more attention in the United Provinces than it usually gets.

A few days ago a passage on page XIII of the introduction to "A Forest Flora for Kumaon." (A. E. Osmaston, 1927) happened to catch my eye. It states that "In most sal forests of whatever type, sal comprises 80 to 90 per cent. of the dominant tree species, and tends to form a dense canopy. That the virgin sal forests contained a much higher percentage of miscellaneous species than our present forests cannot be doubted. Large sums are annually spent in eliminating all such comparatively worthless species, and the balance of nature is now heavily weighted in favour of sal and a few other valuable timbers." For the last 9 years I have been wondering if the relentless warfare waged against *kokat* in the sal forests of the U. P. is wise, and I have been gradually coming to the more and more certain conclusion that it is not. As sal, whereever it exists, is by far the most valuable species it is certainly very tempting to favour it on every occasion, and even though a certain admixture of miscellaneous species has at times been advised in the marking prescriptions of working plans, the tendency in practice has always been to neglect this sound advice, and in the majority of cases miscellaneous species are hacked out whenever possible. From the silvicultural point of view I feel certain that this policy is unwise, and more especially in areas where definite attempts to obtain regeneration are being made, as in P. Bs. I & II of forests under conversion to uniform.

Most of the factors which make the regeneration of sal forests so difficult have been enumerated in great detail in two long articles in the "Indian Forester"—one in September and October, 1927, by Mr. F. C. Ford-Robertson, and the other in November and December, 1928, by Mr. F. C. Osmaston—see also the article by Mr. E. A. Smythies in September, 1929. I need not, therefore, repeat them here, but I would emphasise the fact that the purer the sal the greater is their deleterious effect when they are adverse, especially when the sal is fairly even-aged and has a canopy at a considerable height above ground and there is little or no middle story (and we have brought a large number of our sal forests to this condition),

I may mention that the chief adverse factor I have in mind is bad texture, drainage, and aeration of the surface soil, which is made worse by the dead leaf layer and also by the above condition of a high more or less uniform canopy with little or no middle story. It is thus obvious that the purer the sal the worse will this become. With regard to the dead leaf layer, we cannot burn this every year and in every type of forest. It must, therefore, be an advantage if we lessen the number of sal leaves and increase the number of other smaller and less coriaceous leaves, and thus from both points of view an admixture of miscellaneous species with the sal is to be advocated. Mr. Ford-Robertson does not touch on this subject except when he states that "it is constantly observable in dense unburnt sal forests that reproduction is found largely below patches of *kokat* or in small blanks". Mr. Osmaston, however, writes at considerable length on the advantages of having a mixture of miscellaneous species with sal. I think it is generally recognised that sal will regenerate more easily under most miscellaneous species than under trees of its own species, and yet this tendency to remove *kokat* on any pretext whatever continues.

I have seen regeneration fellings in sal carried out in many different ways, and in almost all cases very nearly all the miscellaneous species in the upper and middle canopy had been taken out wherever possible. In most of these forests before regeneration fellings were carried out there was a considerable number of *kokat* trees, if not amongst the dominant, at any rate amongst the dominated trees, and often forming to a greater or lesser extent a middle story. If, therefore, the presence of *kokat* helps sal regeneration in its early stages, as I believe it does, why cut it all out? It seems to me that if regeneration fellings are to be carried out in a forest where there is not sufficient established regeneration (and of course also where there is insufficient unestablished regeneration), it would be wiser and safer to base the fellings on the following principles :—Provided sufficient good seed trees of sal are left at suitable intervals other species should always be left in preference to sal, the

number to be left depending on the degree of light to be admitted, remembering that until sufficient sal regeneration is established it is probably unwise to expose the soil too much, and that in addition to any miscellaneous species which it is possible to leave in the upper canopy, a light middle story of miscellaneous species is very desirable.

If this is the ideal to be aimed at when regeneration fellings are commenced, it is obvious that when thinnings or other fellings are done in P. B. II the tendency to cut out all *kokat* must be checked here also, especially as attempts to get regeneration in advance of the regeneration fellings will be necessary in P. B. II. In fact a certain amount of *kokat* should be encouraged from the young pole stage onwards, a few being allowed to grow up as dominant trees, and the rest kept as a middle story.

I am very far from claiming that the above ideas, if carried out, will solve the problem of sal regeneration. They will do nothing of the sort. But I think they would help considerably, if combined with judicious burning and protection from deer when and where necessary, and I am sure that in a forest treated in this way established regeneration will be obtained more quickly and successfully than in some I have seen recently, where widely scattered seed bearers of sal have been left and practically everything else cut out. The ground is now mostly a sea of grass or *kokat* shrubs with no established sal regeneration, and existing seedlings are in a poorer condition than they were before the regeneration fellings were made. If a middle story of miscellaneous species had been left, it would at least have helped to cover the ground and keep it in a better condition for the germination of new seedlings and the development of existing ones.

I would also emphasise the fact that this is no new idea. I believe many forest officers hold similar views to a greater or lesser extent. The reason I have written this note is to draw attention to the fact that even though others hold similar views, and even if somewhat similar principles have been laid down

in some working plans the relentless warfare against *kokat* continues unchecked, and our sal forests continue to be "improved" and incidentally made more and more difficult to regenerate.

THE REGENERATION OF THE SAL IN THE UNITED PROVINCES.

BY M. D. CHATURVEDI, I. F. S., SILVICULTURIST, U. P.

The natural regeneration of the sal constitutes our main problem to-day. So much has already been written on the subject, that it is not without much diffidence that I crave the indulgence of the reader to examine the writer's analysis of the sal problem. The natural reproduction of sal has continuously engaged our attention for the last 18 years and I have been myself intimately associated with it for the last 6 years. We have tried to regenerate the sal by every conceivable means: with manipulation of canopy and exclusion of game, with fire protection and controlled annual burning, with soil preparation and shrub cutting, and with the permutation and combination of all these factors; in fact we have left no region unexplored, no vein uncut. The results to date are, however, negative in the main and indicate unmistakably that the lines along which the investigation of the sal problem has been hitherto concentrated must be considerably modified if success is to be achieved.

2. Mr. Smythies (1) has recently drawn pointed attention to the sal forests in Nepal and the ease with which they regenerate, despite the fact that these forests are neither inspected nor looked after; neither thinned nor protected against cattle and accidental fires. Indeed, according to our accepted notions of the silviculture of sal, these forests are being mismanaged and maltreated in the extreme. The existence of copious natural regeneration in these areas, however, drives us to the irresistible conclusion, that our regeneration methods are all wrong and that to regenerate sal it seems essential to give it the same treatment which is meted out to it in Nepal. The factors which operate in the regeneration areas in Nepal may therefore be examined here in some detail, and we may not introduce identical

conditions in our forests without sifting and selecting the evidence if further disappointments are to be avoided.

A. BURNING.

3. In our best quality semi-moist sal areas where favourable soil conditions exist, the elimination of the competition of the sal seedling with weeds is our real problem. The comparative freedom of the Nepal forests from weeds has been ascribed to the fact that they have been burnt almost annually since time immemorial. Our fire protection policy which has been in force for the last 50 years would, therefore, appear to have been wrongly applied to the sal areas of semi-moist types. There is little doubt that continuous fire protection favours the growth of evergreen weeds and renders their elimination from the regeneration areas increasingly difficult. Continuous annual burning, on the other hand, leads to a progressive reduction of weeds only in size and not always in number, along with the disappearance of young sal seedlings as well. Continuous burning is inimical to all vegetative growth and our experiments* ranging all over the habitat of the sal in these provinces reveal the fact that burning cannot reduce weeds without effecting a corresponding reduction in the sal seedlings, both in size and extent. One to two season old sal seedlings have less resisting power against burning than their associated weeds. It has been already shown by the writer that young sal seedlings following a good *seedling* year (*recruitment*) should be protected, under *average* forest conditions for at least 2 years before they can be burnt with impunity. (2) Fires in the Nepal areas must therefore be assumed to have been light enough to let the young seedlings survive; and the quantities of regeneration which exist cannot be accounted for without granting an occasional protection here and there to let the *recruitment* attain the size of immunity to burning. While

* The following seven experiments on continuous annual burning exist in the United Provinces :—

Dehra Dun	1
Haldwani	3
North Kheri	1
Ramnagar	1
Pilibhit	1

an occasional accidental fire, or a controlled periodic burning in forest areas in general, has been demonstrated by Gibbs and Werkman (3) to secure ideal neutral conditions for the bacterial activities in the soil, a *continuous* annual burning, apart from eliminating weeds and *recruitment* alike, is also calculated to kill the bacteria and render the soil sterile. Periodic accidental fires in Nepal must have been, therefore, very light to permit the *recruitment* to establish themselves, and cannot possibly account for the comparative freedom of these areas from weeds. Indeed, their influence on the reduction of weeds must have been as negligible as it has been on the sal seedlings. The reason for the scantiness of the weeds in the Nepal regeneration areas should be, therefore, sought elsewhere.

B. Light.

4. *Ceteris paribus*, the factors of growth show no selective tendencies and influence both weeds and sal seedlings alike. Nature does not recognize the economic importance of sal. Thus, light has no prejudice against weeds and favours their growth as much as that of sal seedlings without distinction. The response to light, however, varies due to specific physiological differences. As a general rule the weeds react to improved light conditions much more than the unestablished sal seedlings. A heavy interruption in the upper canopy (10 to 12 standards to an acre) followed by an annual or periodic burning is not likely to secure the natural reproduction of sal within an economic time limit, and will lead to, as it has done in the past, an invasion of weeds and grasses difficult to control. For whenever the *recruitment* is protected for a couple of years from burning, the weeds will be protected as well and will shoot up much higher than the young seedlings, and will literally swamp the area*. It should be emphasized here that we cannot open the upper canopy to provide more light for the *recruitment* or unestablished seedlings without also encouraging the growth of weeds. For, although

* An area (Lakhmanmandi 1, iv, Haldwani) which had been burnt almost continuously ever since 1921 (except in 1924 and 1928) and had an extremely severe fire in 1929, was found to be full of dense weeds after a single year's protection during 1930.

an increase of light is beneficial to sal seedlings, it is even more so to the development of weeds: moreover whereas the sal regeneration is generally absent when this operation is carried out there are usually large quantities of weeds on the ground to take the fullest advantage of improved light conditions.

C. SOIL.

5. The soil factor operates in the same manner as light. Good fertile and well drained soils expedite the growth of weeds and sal seedlings alike, and bad soil conditions retard the growth of both. The adaptability of some species to poor soil conditions helps them to establish themselves in areas to the exclusion of others not capable of adjusting themselves to inferior nourishment. In better types of soils the difference in the rate of growth of various species is the determining factor in the struggle for existence: the slow growing species are usually suppressed and ultimately wiped out. In the rich *bhabar* semi-moist areas, where soil conditions are favourable, the comparative rapid rate of growth of weeds militates against the sal which, in its early stages at least, cannot hold its own against them.

6. Under fairly dense sal overwood, the partial decomposition of the heavy leaf layer falling annually from sal trees under conditions of limited supply of air and light, apart from acting as a mechanical barrier between the seed and the ground [Dr. Troup (4)], tends to render the soil demonstrably acidic, causes bad soil aeration, and inhibits thereby the establishment of all species in general and sal in particular. While evergreen weeds adapt themselves to these unhealthy conditions to some extent the sal is again handicapped and is usually kept out primarily owing to an unfavourable soil factor rather than to the direct effect of shade, Dr. Troup (5). The opening up of the upper canopy is indicated in these areas, not so much for an increase in the incident light for photosynthetic purposes of plants, as for the attendant heat which is a concomitant feature of light, to decompose the acidic humus overlying the soil and render it neutral for active nitrification, Hesselman (6). Messrs. Sen and Ghose (7) have recently demonstrated the progressive increase of

the nitric contents of the surface soil from July to December in a cleared plot, and a continuous decrease of the nitric nitrogen in the plot with a leaf cover during the same period. An *occasional* fire accomplishes the same object with considerable ease. The function of the white ants in the decomposition of the heavy leaf layer is also by no means unimportant. These improved light and soil conditions brought about by the manipulation of canopy and an occasional fire expedite the development of weeds more than that of sal seedlings. Thus, by creating favourable soil conditions the periodic fires favour rather than retard the growth of weeds.

D. Game.

7. Game has recently engaged our attention in sal areas as being one of the most important factors which seems to operate against the establishment of sal seedlings at a certain stage of their development. This is true to a large extent where game is plentiful and regeneration areas are limited. Where regeneration areas are extensive, as in Dehra Dun, the damage due to game is so widely distributed that it becomes negligible; and the solution of the problem would seem to lie in forming larger regeneration areas than in wove wire fences. Game proof fences, however, have been found to increase the weed competition. In the experimental plots from which game has been excluded, the growth of both the weeds, as well as of sal seedlings, has been definitely observed to have been accelerated. Game thus keeps down weeds as well as sal seedlings, and game proof fences do not afford any solution against weed competition.

E. Overwood.

8. It has been almost universally observed that sal seedlings do not flourish under a sal overwood. Mr. Hole (8) has shown that the inferior growth of sal seedlings in the shade of the forest is due primarily not to deficient light, to unsuitable air temperature or air humidity, but to an injurious soil factor. The partially decomposed heavy sal leaf layer *seems* to produce auto-toxic soil conditions which inhibit their growth. The

weeds can, however, adapt themselves to these conditions (toxic only to sal), and are kept in check only owing to lack of sufficient overhead light. When, however, the overwood is light and consists of miscellaneous species notably of light foliage with a sprinkling of sal here and there, the soil conditions are rendered favourable to sal seedlings which then occur as freely as weeds. The weeds, as has been pointed out above, are kept in effective check owing to insufficient light which is mechanically cut off by the overwood, independent of the fact whether it is composed of sal crowns or crowns of other species. In its early stages of development the sal seedling, as its shiny coriaceous leaf suggests, can adapt itself much more to the limited supply of light than weeds, and flourishes while the weeds are starved for light. When, however, the advance growth of sal has established itself and weeds have been rendered weak by a continuous deficiency of overhead light the overwood can be removed with impunity. The advance growth will now respond to increased light much more than the etiolated weeds and will ultimately suppress them. Here, I believe, are the optimum conditions which a miscellaneous overwood secures, favourable for the development of the sal seedlings and inimical to the progress of weeds both in *space* and *time*.

9. The sal areas in Nepal, from the little I have seen of them, have a type of overwood very similar to what I have described above. The upper canopy in these areas consists of miscellaneous trees interspersed here and there with mature sal mother trees. Mr. Marriott (9) describes the upper canopy as mixed overwood of sal and *other trees* many of which are probably 300 or 400 years old. The upper canopy is very open with respect to sal alone but otherwise it should be described as light. It is this light miscellaneous overwood which keeps the weeds in effective check, and the importance of fire, if any, in the control of weeds is only *secondary*. The Nepal areas are usually exploited only for the sal and almost all of its associates are left severely alone. A few seed bearers are retained here and there. The very nature of fellings carried out in the past in these areas seems to have resulted in a type of overwood

which secures ideal conditions for the development of sal seedlings and the elimination of weed competition. The accidental fires are, if any thing, harmful to the *recruitment* and unestablished regeneration. It would appear, therefore, that in the process of alternation of species the sal overwood should be gradually converted into a miscellaneous overwood before sal could reproduce itself.

10. Instances illustrating the advance growth of sal thriving under a miscellaneous overwood can be easily multiplied in the Haldwani and other divisions. The Dehra Dun division affords a number of examples illustrating this phenomenon, the best of them being an area near the Phanduwala rest house. In the Lakhmanmandi area (Haldwani), where we have unsuccessfully tried to establish the regeneration of sal by manipulating the upper canopy in a variety of ways, and in the Sela block (Haldwani) examples of the advance growth under miscellaneous overwood are not uncommon. The extensive advance growth in the Dehra Dun division despite deer and fire protection, which is otherwise difficult to explain, can at least be partly ascribed to the slight admixture of miscellllneous trees in the overwood and largely to well aerated soil conditions.

11. The explanation of the disappearance of the sal regeneration from our forests is, therefore, not to be sought so much in our game and fire protection policy in the past, as in our marking rules which have been directly responsible in reducing the proportion of the miscellaneous species from our sal areas beyond the critical point. By definitely favouring sal at the expense of miscellaneous trees, we have upset the interdependent relation of sal and its natural oecological associates. Miscellaneous species constitute an indispensable nurse for the sal seedling and every single nurse removed from sal areas in thinnings and the so called improvement fellings militates against its establishment.

12. *En passant* attention may also be drawn to the poor response of the sal regeneration to the uniform system recently introduced in the sal areas in these provinces (with the probable

exception of Dehra Dun and to some extent Ramnagar). The regeneration of sal is conspicuously absent from evenaged stands. It is too early to express any views on this system of concentrated regeneration, but it is not unlikely that the conversion to uniform system may ultimately prove to be illusory, and we may have to revert to the selection system in some modified form.

CONCLUSIONS.

13. An analysis of the factors of growth which operate in the sal regeneration areas in Nepal and in these provinces gives the following indications:—

(*a*) The real significance of the light periodic accidental fires lies in the improvement which they effect in the edaphic factor, and in the destruction of the mechanical barrier which the ever accumulating leaf layer forms between the seed and the ground. *Ceteris paribus*, occasional fires by securing improved soil conditions would favour rather than retard the growth of weeds as well as of sal seedlings. Continuous annual burning affects adversely both the weeds and the sal regeneration, and in the early stages of its development the sal seedling suffers much more from fire than the weeds.

(*b*) The explanation of the comparative freedom of weeds from the regeneration areas in Nepal is not to be sought in the fires which frequent them but in the existence of a light overwood of miscellaneous species which starves the weeds of the necessary overhead light. It is this miscellaneous overwood which keeps the weeds in effective check, and the importance of fire, if any, in the control of weeds is only *secondary*. Indeed, the influence of fires in the reduction of weeds must have been as negligible as on the sal regeneration which abounds in these areas.

(*c*) While the sal overwood is detrimental to the development of the young seedlings underneath it, the upper canopy consisting of high miscellaneous trees notably of light crowns secures the ideal conditions for the natural regeneration of the sal to flourish. In its early stages of development the sal seedling can stand a lot more overhead shade of miscellaneous species than weeds. It is this miscellaneous overwood, rather than the frequent fires detrimental to the sal regeneration, which has brought into existence quantities of advance growth in the Nepal sal areas by eliminating the weed competition.

(*d*) In the process of alternation of species the sal overwood should be gradually converted into a miscellaneous overwood before the sal could establish itself again on a given area.

(*e*) Game proof fences accelerate the growth of both the sal seedlings and the weeds alike and do not afford any solution against weed competition.

14. To prove my *hypothesis* all that is needed is to burn a compartment continuously during the period immediately before it is included in the P.B.I. for a few years to counteract the evil effects of the unnatural fire protection policy. Although this operation will reduce weeds to some extent and will kill out all existing seedlings, if any, it will secure ideal soil conditions for the *recruitment* to come in. Attempts should be made to scrupulously preserve every single tree of miscellaneous species and if need be, interfering sal should be sacrificed for its development. In the thinnings carried out during this period all high light crown miscellaneous trees in the mid-canopy should be retained as a cover on the ground, and thinnings should be confined to sal trees alone. When the compartment is included in the P.B.I., the sal overwood should be reduced to about 20 (?) trees to an acre with the specification that no blank is created which is not lightly covered by a tree of miscellaneous species in the

vicinity. The area should be burnt periodically *before* good seed years *only* till the area is fully stocked with *recruitment.* The sal overwood can be progressively reduced later as the state of regeneration, and the existence of cover from the miscellaneous species, suggest. With the advent of the advance of growth a rigorous fire protection should be enforced. Although, the almost pure condition of our sal forests does not provide opportunities to investigate this method of regenerating sal on a large scale, small plots can always be found with an admixture of miscellaneous species to test the method outlined above.

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PROBLEMS OF FOREST MYCOLOGY AND PATHOLOGY IN INDIA.*

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History.—As far as data are available, it appears that no regular and systematic study of the diseases of forest trees in India caused by fungi was made in the past. Previous records merely consist of occasional notes or short papers by various officers describing the few species of forest fungi which they

* Based upon a paper read in the Staff Meetings of the Forest Research Institute, New Forest, Dehra Dun, on the 17th March 1931.

came across. Of these, the earliest papers were published by M. C. Cooke (1, 2, 3, 4, 5,) in 1876 to 1879 in the "Indian Forester," in which a large number of fungi collected by Gamble were described. Subsequently Barclay (8, 9, 10, 11, 12, 13, 14, 15), in 1889 to 1892, described several forest rusts which were published partly in Scientific Memoirs by Medical Officers of the Army of India and partly in the Journal of the Asiatic Society of Bengal. Nisbet (16) in 1895 published short notes on the occurrence of rots and cankers, etc., the causes of which were practically unknown. This was followed by a list of some Indian fungi by Gamble (17) in 1899.

Apparently this gave stimulus to the subject and within the next few years (1900 to 1904) a number of notes were published by various authors chiefly by Troup (18), Fernandez (19), Brandis (20), Coventry (21) and others. In 1905 Butler (22) made a careful systematic study of some of the important forest fungi and published a series of articles in the "Indian Forester." Others, notably Troup (23, 24) and Hole (25), between 1910 to 1914 pointed out the field for mycological, pathological and ecological research. But the investigations up to this time were directed more to pathological research than to any systematic study of the causal organisms. The spike disease of sandal was one of the interesting problems which engaged the attention of Forest Officers and preliminary notes on the sandal disease were published by Barber (26), Benson (27), Rao (28, 29), Lushington (30) and others (31) between 1904 to 1906, and the results of Hole's investigation (32, 33, 34) on the subject was published in 1917. He postulated the theory of unbalanced sap-circulation as the cause of spike disease and this raised a series of controversies as evidenced by a number of articles by Fischers (35), Lushington (36, 37), Ayyar (38), Howard (39), Coleman (40), Jackson (41), Latham (42, 43) and others (44), (45) which appeared in the "Indian Forester" and elsewhere from 1917 to 1927. Practically a period of more than a decade was spent over this problem by various workers without any definite conclusion being arrived at. The latest opinion on this subject is that the disease is due to either some kind of virus

or partly to physiological causes and partly to virus. The problem is now being investigated by the Research staff of the Institute of Science, Bangalore, by the Mysore State Officers, and by the Forest Department, Madras. Being workers in the field they are better able to study the problem than we are from the Forest Research Institute.

Simultaneously with the sandal spike research there were also other investigations in progress, specially the study of wood rotting fungi, which was started by Butler (46) and notes on these were contributed by Cooper (47), Haines (48), Glover (49) and others (50), Troup (51) and Trevor (52) also made some observations on the parasitic rust on deodar—a disease which has now become widespread in the Kulu and the Beas valley forests. In 1914 Hole (53) took up the study of *Trametes pini* and published the results of his field observations relating to its dissemination and infection by spores in the Indian Forest Records, Vol. V, Part V, 1915. He also suggested some measures for control. This is a well-known forest fungus and has been exhaustively studied by Hartig and others in European countries, especially on the continent. The mode of infection of this fungus, the damage caused by it and the control measures adopted are more or less known. *Fomes annosus*, var. *indica*, Wakf. is another well-known fungus which was first described by Butler in 1903 from Jaunsar. In 1922 Hole (54) again recorded it on spruce (*Picea Morinda*) and on silver fir (*Abies Pindrow*) from the same locality. The fungus has since been recorded on deodar in Simla, Bashahr and Siraj Divisions. In 1922 Hole also discovered *Armillaria mellea* on spruce and this is the first authentic record of the occurrence of this fungus in India. He has given a brief general account of his observations in the "Indian Forester," 1927, with special reference to the presence of rhizomorphs which he thinks belong to this fungus and not to *Fomes annosus* as held by Butler. The removal of infected trees, burning of the rotted stumps, destruction of sporophores, isolation of the healthy trees from the infected ones by trenches, admixture of different forest species, etc., have been suggested as control measures.

Problem under investigation.—These are merely preliminary studies which pave the way for further work. Cultural experiments to demonstrate the parasite nature of fungi on forest trees, the inter-relation of the host and the parasite, the study of environmental conditions which predispose them to such infection and finally the control measures to be adopted from the items of work. The problems which are being investigated at the present time may be enumerated as follows :—

1. Investigations of parasitic rust on forest trees which include various species of Peridermium (58, 60, 61) Cronartium, Coleosporium (57), Melampsora, Uredinopsis, Pucciniastrum, etc.
2. Root-rots of trees which include a large number of fungi under the group Basidiomycetes, *viz.*, Ganoderma, Fomes, Polyporus (55, 56) and also some species grouped under Fungi Imperfecti, *e.g.*, Fusarium, etc.
3. Wood-rotting fungi which also include a large number of Basidiomycetes known popularly as mushrooms, *e.g.*, Polystictus, Trametes, Corticiums, Sterums, etc.
4. Canker fungi—Nectaria and several Ascomycetes not identified as yet.
5. Leaf-defoliating fungi (59) such as the thicket fungus of Sal, Rhytisma on Acer, Phyllactinia on Shisham, etc.

Of these items the rusts and root-rots are of great importance from our point of view. Attempts are being made to work out the complete life-history of all the fungi under investigation so that, if possible, effective remedial measures may be found.

Methods.—It is proper at this stage to describe in brief the general scheme under which problems of forest diseases due to fungi are investigated. We have adopted here a simple procedure for the purpose of every day-work in the laboratory and the methods are based more or less on the lines proposed by the foremost American Phytopathologists, *i.e.*, Whitzel, Rankin and others at the International Phytopathological Congress (62).

Without going much into the details and through the very many sub-divisions under which each head is sub-divided, I may state that a problem is investigated under four principal headings:—

I. Disease.
II. Suspects.
III. Environment.
IV. Control.

I. *Disease.*—There are three sections or sub-divisions under which the disease is referred to, namely:—

A. Name, History and Distribution.

B. Symptomatology—This again is divided into three distinct lines of investigation:—

(*a*) External Symptoms or Signs.
(*b*) Morphologic Symptoms.
(*c*) Histologic Symptoms.

C. Etiology—(Aetiology):—The study of symptoms of disease with reference to the cause. Under this heading the following points are considered:—

(*a*) Morphology of the pathogene—Name and classification of the pathogene.

(*b*) Pathogenesis—Under this problem data derived from experiments—Inoculation, Incubation and Infection, are recorded.

II. *Suspects.*—Plants affected are considered with reference to varietal susceptibility.

III. *Environment.*—An understanding of the cause of the disease is essential to the undertaking of adequate control measures. The tree is a living organism which requires water, food, air and sunlight. Many of the diseases of forest trees are due to the failure to recognise the importance of maintaining suitable conditions for tree growth. The soil must contain the proper supply of food materials and be of a texture which will conserve the water and air that are necessary for healthy root development. These technical facts regarding the relation between a tree and its environment are often more easily

comprehended than the life-history of the parasites which cause disease. Consequently, the phenomenon which is discussed in a thesis on forest pathology as the "*Predisposing factor*" should be properly interpretated. My conclusion is that as the factor of environment plays an important rôle in the cause of the disease the method of its control should be worked out in the field and supported by investigations carried out in the laboratory.

IV. *Control* may be classed into

Prophylactic or preventive
and
Therapeutic or curative methods.

Plant diseases become established in so insidious a manner that they are often well developed before they can be detected. By the time the disease is evident in a plant it is rarely possible to cure it. In comparison with the human pathologist the plant doctor is handicapped by the absence of such system in plants which correspond to the living blood stream in man, and by the difficulty of introducing substances to circulate in plant tissues which will be toxic to the parasite but harmless to the host. The efforts of plant pathologists are centred, therefore, upon the prevention of the disease rather than its cure.

Under prophylactic methods we will consider the following measures :—

(*a*) Exclusion

(*b*) Eradication.

(*c*) Protection.

(*d*) Immunization.

(*a*) *Exclusion* measures include burning of the infected parts of trees, trenching to isolate the infected members from the healthy ones when the infection passes from one individual to another through the root-system, burning of the spores or organs of the fungus which contain them. This last method is suitable in case of semi-parasites, facultative parasites, wound parasites, etc., so that the spores which are the carrier of infection are reduced to the minimum.

(*b*) *Eradication.*—A measure suitable for the control of heterocious rusts, when the life-cycle passes through two or more members of different families of plants. The elimination of alternate host plays an important part in the control of such disease and the hosts which are useless or commercially less important are eradicated. Diseases of wheat (*Puccinia graminis*) and blister rust of pine (*Cronartium ribicola*) are controlled by eradication of Barberry in the case of wheat rust and Ribes in the case of pine rust. With virus disease one of the effective measures of control is to destroy the insect carriers of the virus.

(*c*) *Protection.*—There may be many kinds of protective measures to save the agricultural and forest crops of a country from fungus infestation. The transport of trees, nursery stocks, even seeds from infected to uninfected areas are now prohibited by state laws. Most civilized countries now maintain an official phytopathological service and legal enactments have been passed in the endeavour to prevent the introduction of new disease and to eradicate those recently established and to check the spread of some of the diseases of long standing.

The adoption of sanitary measures which are effective in preventing certain plant diseases may be considered as protective measure of a local nature. The debris of fallen branches, bark, leaves, etc., which harbours a number of facultative parasitic pathogenes may be periodically burned in order to prevent them from fructifying and this reduces infection considerably. The eradication of jungle stumps immediately after felling is a considerable insurance against the heavy losses to young crops of conifers from the root infection of *Armillaria mellea*. A similar suggestion has been put forward as an emergency measure against *Fomes pappianus* rot of babul in Central Provinces.

With forestry the matter of nursery protection is more urgent, for in many cases there is little hope of disease control other than by the elimination of the cause in the nursery itself. In forests the practical sides of plant physiology are of greater importance in battling with diseases than cure, *i. e.*, avoiding disease by assuring healthy growth for crops as a whole.

(*d*) *Immunization.*—The use of disease-resistant varieties is one of the most effective measures in reducing diseases of plants. With the knowledge of heredity now available, the quality of resistance can also be combined with other good characters by the plant-breeder. Geneticists throughout the world are endeavouring to introduce into cultivation new varieties, synthesized by them, which will be more resistant to disease than those formerly grown and which at the same time possess the desirable commercial qualities of the older type. While from the other side, the plant-surveyors are equally active in their search for new species or races which prove immune to diseases and at the same time possess the required commercial qualities of the types which are to replace.

The culture of immune or resistant species in place of susceptible ones has therefore come into prominence in the domain of agricultural and horticultural science long ago. Attempts are being made in Japan, in the East and in England and on the Continent of Europe to give preference to immune or resistant species of forest trees and wherever possible to replace susceptible ones. Experience with certain types of epidemic disease of forest trees has shown that such selection gives better results than measures of control, for susceptible species which are exposed to infection now and then. One or two examples will illustrate this point.

The appearance of larch canker disease (*Dasyscypha calycina*, Fuckel.) in Britain and the devastation caused by this fungus in larch woods led to a scare in the later years of the 19th century. In some cases the woods were so seriously infected as to justify their removal *en-block*. The European larch (*Larix europea*) was introduced in England in the 18th century and was followed by plantings for a time on a considerable scale. The fact is that owing to the durability and value of wood, all sizes from an early age are utilisable, the species was planted without reference to the kind of soil it required. Two primary causes for the widespread attack to which the larch was subjected are established. The unsuitability to the species of many of the soils or localities in which it was

planted and excessive density of the unthinned plantations. Both are undoubtedly contributory causes to the universal spread of the disease. But it has also been pointed out that the European larch is chiefly affected, the more recently introduced Japanese larch (*Larix leptolepis*) being seldom attacked, on the other hand the West American larch (*Larix occidentalis*) appear to suffer even more than the European.

Spaulding (63) of the Department of Agriculture in the United States has been advocating plantation of *Pinus excelsa* and *P. peuce* which are resistant or less susceptible to blister rust than *Pinus strobus* and other native American pines, for example *P. monticola*, *P. cembra*, and *P. lambertiana* which are highly susceptible. Tubeuf (64, 65) in Germany has appealed for the replacement of the susceptible *Pinus strobus* and *P. monticola* by the immune *P. peuce*.

Direct control of chestnut blight disease (*Endothia parasitica*, Murr., and related species) has become practically impossible, and the department of Agriculture in the United States has been looking forward for the discovery of a suitable strain of chestnut resistant to the disease (66). A number of strains of Asiatic chestnuts have been brought to the United States by the Office of Foreign Plant Introduction of which the Japanese chestnut (*Castanea japonica*, Blume) and the hairy Chinese chestnut (*C. mollissima*, Blume) have considerable natural resistance. Attempts are also being made to find out a resistant strain from the native chestnuts which should be suitable for timber like the susceptible species *C. dentata*, Sudworth.

B. *Therapeutic methods.*—In all control measures care is taken that the treatment suggested is commercially feasible, *i.e.*, the increase in value of the crop should be greater than the cost of treatment. The use of fungicides, etc., not being economic and suitable for forest problems in India are seldom prescribed, specially, at the present time, there is so small a margin of profit in growing and maintaining forest crops that costly measures for controlling diseases by the application of fungicides and other medicinal treatments are prohibitive.

The headings and sub-heads in the above outline are not definitely fixed and occasional omissions of the heads or sub-heads are made when there are no data to record thereunder. Each treatise is supplemented by a bibliographical note regarding information gathered from the works done by other investigators on the same or on similar subjects.

Conclusion.—Tree diseases cause enormous losses in the large tracts of forests in India on which we depend for timber. The fungal flora of the forests of India consist of a large number of species belonging to hundreds of genera. There is, therefore, plenty of scope for research in this line. Though our knowledge of tree diseases has been steadily accumulating since the beginning of the present century, the life-history of most of the Indian forest fungi is practically unknown and, so far as the systematic study of the causal organisms are concerned, very little has been done.

Much remains to be learned about the pathology of the diseases on which reports have been published and still many more have never been investigated. The worker in this branch of technical science is required to be equipped with the knowledge of elements of forestry and silviculture, a knowledge of environmental conditions and plant growth, *i.e.*, ecology, the elements of biological chemistry and also mycology and botany. Intensive field work is essential and this should be combined with laboratory research to carry out the various pathological investigations successfully. There are disadvantages and limitations to this kind of work as well. The most important point with regard to research in forest pathology is the time that each piece of investigation will take. In the first place, fungi, particularly Basidiomycetes which form a large group of pathogenes infecting forest trees, are of a slow growing nature and take a considerable time in developing fruit bodies, even with proper facilities, and secondly, their connection with large sized trees involves a long period before their effect is manifested. In this respect the workers in the sister branch of this science, *i.e.*, in agricultural mycology and pathology are more fortunate—as the life of most agricultural crops are over within one year, so, naturally, the phenomenon that may

be expected would take place in the course of the short life of the plant. Further the tree parasitic pathogenes which are known as "obligate parasites" will seldom grow in artificial media and such organisms will probably tackle the wits of the worker before he can imitate conditions sufficiently closely to those that occur in nature. Finally it is not always possible to guess precisely the sequence of the phenomena so as to arrange inspection at the right moment and to be in the forest to take observations when such phenomena take place naturally. We are here again dependent on Forest Officers. We always count upon their help and co-operation. Being men in the field they are better able to help us with information and observations, and with their co-operation it will be possible to work out the problems of forest pathology to a successful conclusion.

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A SHORT DESCRIPTION OF KOLABA FOREST DIVISION.

BY E. T. C. VAZ, I.F.S., D.F.O., KOLABA.

Kolaba is one of the four districts of the Konkan (a long narrow strip of land situated between the Western Ghats and the Arabian sea), the other Konkan Districts being Thana, Ratnagiri and Kanara, of which the first lies to the north of Kolaba while the other two lie to the south.

The Kolaba Forest Division, as constituted at present, comprises all the forests of the Kolaba Collectorate, Dapoli and Bandh Tivre forests of Ratnagiri and the forests of the Poona District below the Ghats.

Configuration of the ground.—The whole of the area is very rugged and broken. Its eastern boundary is situated high up on the slopes of the Western Ghats, except where a large semi-circular tract of the Pant Sachiv's State of Bhor stretches half way down from the Western Ghats to the sea. From the Western Ghats an intricate net-work of outer hills stretches westwards to the Arabian sea. The hills rise in the east to an average height of 2,000 feet, though some are much higher, one being as high as 4,400 feet.

Geology, rock and soil.—The main rock system is plutonic and belongs to the Deccan traps. In the plains it is found in tabular masses, a few feet below the soil and sometimes standing out as outcrops. In the hills, too, it is tabular, but is frequently found in irregular masses and consisting of shapeless boulders varying from a few inches to several feet in diameter. On the tops of some hills and in parts of plantations in Dapoli in Ratnagiri, this basaltic trap occurs capped with laterite. In such places pure laterite soil is found.

Apart from the above-mentioned laterite tops the soil has been formed by the disintegration of trap rocks, which frequently contain blue and white amygdaloidal crystals, and consists of greyish loam. In the hilly and forest tracts the soil is generally shallow, rocky and stony, the smaller particles having been washed down to form the fertile rice lands of the plains below. It is generally well drained and suited to the growth of teak and more

valuable species of *injaili*. It is astonishingly fertile considering the numerous boulders present.

Climate.—The climate is moist and comparatively temperate. In the cold weather months the thermometer does not register any great extremes of temperature and frost is unknown, but during the hot weather the heat in the interior of the district is decidedly oppressive, especially in the neighbourhood of the Western Ghats, as the valleys are shut off from the sea breezes which keep the coast region cool during that period. The temperature during the hot weather rises above 110 in the interior.

The average rainfall varies from about 90 inches on the coast to about 130 inches in the interior and even over 200 inches at Matheran (a fine hill station and a favourite resort of the Bombay public who cannot afford to go to Mahabaleshwar, the summer seat of the Bombay Government). All this rain, however, falls during the beginning of June and the middle of October. During the rest of the year there is practically no rain and the inhabitants near the foot of the hill ranges find it difficult to secure even drinking water during the hot weather. There is scarcely any arrangement to store the surplus water for the irrigation of *rabi* and other hot weather crops. The whole of the rain water is not only wasted, but, as it rushes down to the sea, it carries with it much of the best of the soil. Sites for bunds and small irrigation tanks abound, but the expense of their construction is beyond the scope of the cultivators, who look to the Government to bring about such improvements.

Composition of the crop.—Kolaba is fairly rich in forests—the total area of the forests being 537 square miles. The Kolaba forests are almost without exception situated on the upper slopes and tops of the hills except for some patches along the banks of creeks and rivers, which yield mangrove and other brushwood. The lower slopes are frequently clothed with *Malki* and *Inam* forests, while the flatter tops and terraces are often cultivated revenue lands. It would appear that the Government forests are situated on those parts of the hills which the villagers did not care to occupy at a nominal assessment during the first Survey Settlement.

The greater part of the forests is comprised of mixed deciduous species which are found on the hill slopes and change into semi-evergreen *injaili* forests as the tops and plateaux are reached, particularly in the east along the main range of the Western Ghats. Here and there one finds open grass areas and scrub, particularly on the hill tops. There are also a few small plantations of *Casuarina* near Alibag and at Harnai and Dapoli.

The chief species are teak, *Terminalia* spp., *Anogeissus latifolia*, *Lagerstroemia lanceolata*, *Adina cordifolia*, *Albizzia* spp. and mango (which is often found on terraces in pure groups known as Mango *Rahats*), *Eugenia Jambolana*, and *Pongamia glabra*. *Shisham* (*Dalbergia latifolia*) is fairly well distributed, but is small and less common. Bamboos are rarely met with, though they are in great demand.

History.—The first forest conservancy took place in 1863, when the forest of Kolaba and Ratnagiri districts were formed into one Forest Division, but the Angria chiefs, who rose to high power in Kolaba and Ratnagiri during the period 1690 to 1840, appear to have carefully guarded their timber supplies. It is recorded that when the Kolaba State fell to the British in 1840 its teak and blackwood supplies were valuable, both in quantity and quality.

With regard to Bandh-Tivre reserve of the Ratnagiri District (which came into the hands of the British in 1818) it is recorded in the Ratnagiri Gazetteer, published in 1880, that the Government teak reserve on the river Jog was planted nearly two hundred years previous to that day (1880) by Kanhoji Angria and, although at the time of writing (1880) most of the Ratnagiri forests had been destroyed, the Bandh-Tivre reserve used to provide for the Indian navy, the highly priced "Bankot knees" from the banks of the Bankot creek. It is also stated that the Maratta Government always cared for its forests, as also did the British Government after the transfer of the districts in 1818, but about 1829 on the suggestion of Mr. Dunlop, the Collector of Ratnagiri, the forests were, for the most part

placed at the disposal of the people, it being thought that the landlords would husband them with care. The people, however, very soon felled and exported practically everything to Bombay, fleets of native craft even being built for the purpose. Until Mr. Dunlop's proclamation, the forests on the southern bank of the Shastri and the Bav rivers had stood almost intact, but thereafter most of the Ratnagiri forests disappeared.

Rights and Privileges.—There is a privilege peculiar to Kolaba Division by virtue of which the Khots of 320 villages get one-third of the forest revenue from fellings under the Survey Settlement. In this way the Kolaba Division pays out about Rs. 10,000 per annum.

In 1846-47 orders were issued that, in each Khoti and Khalsa village from $\frac{1}{8}$th to $\frac{1}{12}$th of the village area was to be set aside as forest and the Khots of the villages were compelled, by virtue of a clause of the agreements entered into, to protect these areas without any extra remuneration or share in the forest proceeds. Later on, in order to ensure better conservancy, Dr. Gibson seems to have entered into an agreement with some of the Khots providing for the payment of $\frac{1}{3}$rd share of the forest produce in return for the protection of their respective forest areas. Subsequent to this, during the Survey Settlement, a clause was inserted in the survey lease acknowledging the $\frac{1}{3}$rd share in the net proceeds of the forests of the villages concerned. As the Khots were found to be neglecting the protection of the forests, an attempt was made in 1883 to cancel the $\frac{1}{3}$rd share but the Remembrancer of Legal Affairs opined that the concessions once made by Government could not be withdrawn. The Khots are bound to protect the forest, as directed by the Forest Department and they acknowledge pecuniary responsibility for any loss to the forest caused by their neglect. Quinquennial inspections of Khoti forests are, therefore, made and the value of the thefts noticed is charged against the share to be paid to the Khot when that forest comes to be exploited.

System of Management.—Two regular Working Plans were first introduced for Central and Southern Kolaba in 1895 and

1898 respectively. They were revised in 1905-06 and one Working Plan was then drawn up for the whole of the Kolaba Division. This plan prescribed coppice with standard system, under a rotation of 40 years. This in term was revised in 1923-24 and the revised plan now in force prescribes clear felling with artificial regrowth.

Lines of export.—The Kolaba Division is well provided with lines of export, as it has a large number of metalled roads with fair weather feeder cart tracks, and also numerous navigable creeks. In addition, the Great Indian Peninsular Railway runs through Karjat and Pen Ranges in the north of the District, with a short branch line from Karjat to Khopoli and the Roha-Bhira Railway (narrow gauge), constructed by the Tata Power Company, runs through the Roha and Mangaon Ranges.

Markets.—About 60 per cent. of the timber produced is exported to Ratnagiri, or to the Deccan, and 55 per cent. of the fuel and practically all the charcoal is exported to Bombay. The remainder is consumed locally.

Shikar and Fishing.—For so hilly and wooded a district Kolaba is very poorly stocked with game. Tiger are practically unknown. Panther, sambhar and chital are found in Roha Habsan forests. The four horned antelope, called *bhekar* (*Tetraceros quadricornis*) is found in almost every forest.

As the tide runs far up the creeks and rivers fresh water fisheries are very restricted and are of small value. However sea fisheries, specially of the Alibag villages, are of considerable importance.

ALIBAG,

Dated 28th June, 1930.

SHOOTS PRODUCED BY ANJAN (HARDWICKIA BINATA).

BY K. P. SAGREIYA, I.F.S.

In the "Indian Forester" for July 1930, Mr. Vahid has challenged my contention that the following conclusions drawn by me ("Indian Forester," August, 1929) are more justified from the

data than those given in his original note on the subject ("Indian Forester," March, 1929):—

(*i*) The shoots on stumps belonging to girth classes II, III and IV do not show any marked difference in growth, and are on an average 22′ long and 15″ in girth;

(*ii*) The growth of pollard shoots is best when the stumps are 12″ high; and

(*iii*) Mortality is least when the stumps are 24″ high (compared to lower stumps), and that it may be even less amongst stumps which are higher......Casualty figures seem to indicate that, in places where the desiccating effect of the sun and soil is not so severe as in Nimar, it may be possible to cut trees even lower, without adding to the number of failures.

As Mr. Vahid has given only the average dimensions of the dominant shoot for the various stump-heights and girth-classes and not the actual measurements of individual shoots, it cannot be ascertained if our data conform to the normal law of error, and as such I have not attempted to test the figures by standard statistical methods.

Assuming, however, that all doubtful measurements have been rejected, the data, as given in Mr. Vahid's original note, can be suitably grouped and the effect of the vatiables can be studied by averaging. My conclusions, quoted above, were obtained according to this method, and I give below the details of my calculations. Certain preliminary remarks are, however, necessary.

Undoubtedly, the object of the experiment in question is to evolve the best method of pollarding *anjan*. With this end in view a few trees of various girths were pollarded at various heights in Nimar some years ago and have been under observation since. A record has been kept of the dimensions of the dominant shoot on each stump at the end of every five years. In other words, the vigour of the dominant

shoot is the index adopted for measuring the success of a stump, and the girth and the height of the stumps are the variables considered. As the death of a stump counts as a failure, the extent of casualties amongst the various girth-classes and stump-height classes has also been studied.

Now, the growth of the *dominant* shoot is apt to be affected by the presence of *other* shoots on the stump, and as such it will not be a correct measure of the vigour of the stump. The number of shoots is not likely to be the same on all the stumps and consequently their influence on the dominant shoot will also not be constant. It is, therefore, absolutely essential that the effect of this uncertain factor must be carefully eliminated as far as possible, if reliable conclusions are to be obtained.

By the bye, where financial yield is the ultimate consideration, the true indicator of the success or otherwise of a stump will be the value of *all* the utilisable shoots produced by it and not the dimensions of the most vigorous shoot only. Unless, therefore, we presuppose that the stump which produces the most vigorous dominant shoot also produces the greatest number of utilisable shoots our experiment becomes one of theoretical interest only. As, however, I am not concerned, at the moment, with this aspect of the question I shall not dilate on it any further.

To resume, the effect of the variation in the girth and the height of the stumps on the growth of the dominant shoot; and on the extent of casualties amongst the stumps, can be studied in two ways—(1) by considering the *combined* effect of the two variables, or (2) by studying the effect of each *separately*. The main objection to deductions based on the first method is that as the samples considered in our experiment are few, the number of observations in each of the groups (of stumps of a particular height *and* girth class) to be considered becomes so small that the law of probability gets practically no chance to act itself and eliminate the influence of disturbing factors, such as the number of shoots per stump, change in locality, etc., and abnormalities are apt to vitiate our conclusions. In fact, this is the main reason why Mr. Vahid has not been able to establish any clearly defined

relationship between the growth of the shoots and the varying factors. On the other hand, when the effect of each variable is considered separately, a much greater number of samples are obtained in each group (of stump-height *or* girth-class) and the law of averages has a greater chance to obviate the influence of extraneous factors. I have followed the latter procedure, and as will be seen later, more consistent results are obtained.

When studying the effect of girth-class variation, I have assumed that the influence of stump height variation, on the growth of the dominant shoot, is equally distributed amongst all the girth-classes; and *vice versa.* A glance at the table given below will show that in all girth-classes about the same proportion of trees is pollarded at the various stump-heights; similarly, almost an equal number of trees of each girth-class are cut in all the stump-height classes. Considering the fact that we are entirely ignoring one very important factor, *viz.,* the influence of other shoots on the dominant shoot, the error involved due to this assumption will not be very great.

Table showing the number of trees measured in the years 1911 and 1924 respectively.

Girth Class	Height of stumps. 6″ (Number of trees measured in) 1911	6″ 1924	12″ 1911	12″ 1924	18″ 1911	18″ 1924	24″ 1911	24″ 1924	30″ 1911	30″ 1924	Total 1911	Total 1924	Remarks.
I	20	20	20	19	21	19	18	18	23	23	102	99	The table is prepared from the casualty chart given in Mr. Vahid's original note. The figures are tabulated diagonally to facilitate totalling.
II	23	20	23	20	24	23	22	22	22	22	114	107	
III	13	5	13	10	14	12	13	12	13	11	64	50	
IV	7	4	5	2	6	4	6	6	7	6	31	22	
V	5	1	2	1	2	1	3	2	4	3	16	8	
Total	68	50	63	52	67	59	62	60	67	65	327	287	

In the absence of any information whether Mr. Vahid's averages correspond to the mean, the mode or the median, I have presumed that the figures given in the second table in his note represent the arithmetical mean averages; and, in calculating the dimensions of the average shoot for a particular class, I have weighed these figures according to the number of stumps of which they represent the averages. An example will make this quite clear. The height of the average dominant shoot for girth class in the year 1924 is given by :—

$$\frac{(5 \times 22'9'') + (10 \times 24'5'') + (12' \times 22'5'') + (12 \times 20'9'') + (11 \times 22'4'')}{(5 + 10 + 12 + 12 + 11)}$$

which, when simplified, comes to 22′5″ (to the nearest inch); whereas Mr. Vahid's figure 22′ 6·4″ (20′ 6·4″ looks obviously a printing mistake) seems to have been derived as follows:—

$$\frac{22'9'' + 24'5'' + 22'5'' + 20'9'' + 22'4''}{5}$$

The latter method of arriving at the average will give accurate results only when the frequency distribution is quite uniform. Such, however, is not the case in the experiment under consideration, and figures obtained by this method will not correctly represent the average. Hence my preference for the weighted average, even though the calculations are somewhat more lengthy.

Working on the lines indicated, the following results are obtained from the measurements taken in 1924 :—

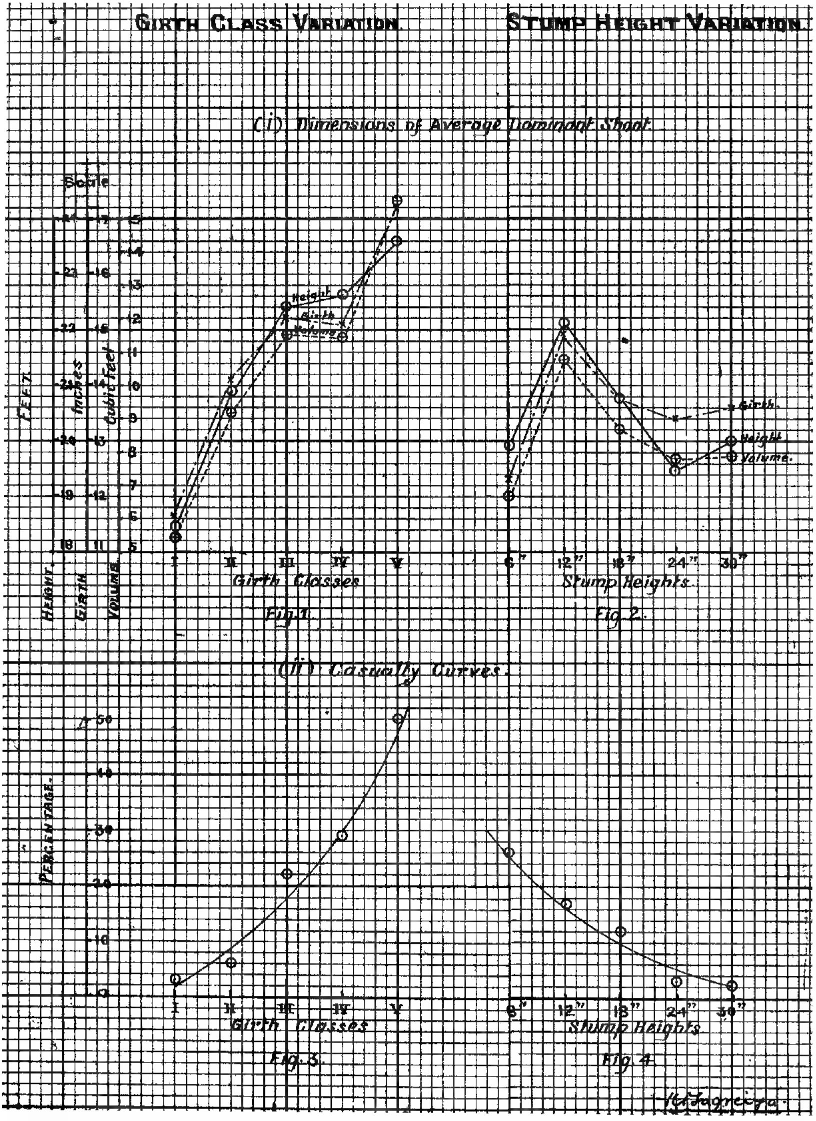
(1) Effect of girth-class variation.

Girth class.	Dimensions of average dominant shoot. Height.	Girth.	Volume ($\pi r^2 h$.)
I	18′5″	11·5″	5·4 cft.
II	20′11″	14·1″	9·2 cft.
III	22′5″	15·2″	11·5 cft.
IV	22′7″	15·1″	11·4 cft.
V	23′7″	17·2″	15·4 cft.

(2) Effect of stump height variation.

Stump Height.	Dimensions of average dominant shoot. Height.	Girth.	Volume ($\pi r^2 h$.)
6″	19′10″	12·3″	6·6 cft.
12″	22′1″	14·9″	10·7 cft.
18″	20′9″	13·7″	8·6 cft.
24″	19′6″	13·4″	7·8 cft.
30″	20′0″	13·6″	8·2 cft.

These results are plotted graphically in figures 1 and 2 respectively. It will be seen that a smooth curve drawn (not shown in the figure) to show the general trend of the points has


GIRTH CLASS VARIATION.
STUMP HEIGHT VARIATION.
(i) Dimensions of Average Dominant Shoot.
Scale
FEET
Inches
Cubic Feet
HEIGHT.
GIRTH.
VOLUME.
Height
Girth
Volume
Girth Classes
Stump Heights
Fig. 1.
Fig. 2.
(ii) Casualty Curves.
PERCENTAGE.
Girth Classes
Stump Heights
Fig. 3.
Fig. 4.

a definite point of inflexion * in the neighbourhood of class III. It is distinctly flattened out here and justifies my conclusions that in the girth interval II to IV, although the dimensions of the average dominant shoot still go on increasing with increasing girth, the rate of increase is not so pronounced as it is outside this limit. The average (arithmetical mean) shoot for this interval will be 22′ long and 14·8″ in girth. In my previous note I gave the latter figure as 15″, *i.e.* to the nearest inch, as I was primarily dealing with the *rate* of growth and not with the actual dimensions. On the other hand, Mr. Vahid, while trying to refute my contention, has actually given the averages approximated to even a greater degree than the original measurements, a thing which is hardly consistent with the principles of the theory of averages!

Fig. 2 speaks for itself and justifies my conclusion that the growth is best when the stumps are 12″ high and that it may be still better beyond 30″.

As to the casualties the following relationships are obtained :—

(3) Effect of Girth-class variation.

Girth class.	Casualties.
I	3 %
II	6 %
III	22 %
IV	29 %
V	50 %

(4) Effect of Stump height variation.

Stump height.	Casualties.
6″	26%
12″	17%
18″	12%
24″	3%
30″	less than 3%

These results are plotted in figures 3 and 4 respectively. The graphs decisively tend to show that the thicker the stumps the higher the mortality and the higher the stumps the lower the mortality. Now, the higher a stump, the longer is the distance of the roots from the exposed surface and consequently the lesser will be the desiccating effect of the sun on them. Similarly the thicker a stump the greater is the area of the cut surface compared to the length of the active cambial layer, the latter being proportional to the radius of the stump while the former varies as the square of the radius. Thus the conclusion that

* At this point the tangent instead of being wholly above or below the curve actually cuts it.

desiccation is one of the chief factors responsible for the death of stumps is mathematically justified.

Lastly, hardly any imagination is required to see the validity of my contention that the effect of desiccation may not be the same everywhere and, as such, conclusions arrived at in Nimar may not be of universal application. The following table gives the figures of rainfall and temperature for the various localities where *anjan* occurs in the Central Provinces :—

Locality.	Temperature °F.						Rainfall.
	Maximum.			*Minimum*			
	Jan.	May.	Jul.	Jan.	May.	Jul.	
Nimar (Khandwa) ...	84°	107°	87°	52°	81°	75°	31·5″
Hoshangabad ...	80°	108°	87°	52°	80°	75°	47·0″
Pachmarhi	71°	95°	76°	48°	75°	68°	77·0″
Average	*76°*	*102°*	*82°*	*50°*	*78°*	*72°*	*62·0″*
Chanda	86°	110°	89°	54°	82°	76°	49·0″
Buldana	81°	101°	84°	59°	78°	71°	29·7″

NOTE.—(1) *Anjan* grows on the lower slopes of the Pachmarhi hills, and the conditions obtaining in this locality may be taken as the average of those at Hoshangabad and Pachmarhi.

(2) The figures (approximated) represent the average of the last 30-40 years and are taken from the District Gazetteers.

Whether this difference in climatic condition justifies my remark that conclusions based on the Nimar experiment cannot be applied to other localities without modification, I shall leave the reader to judge for himself.

Before concluding this note, a few remarks as to the practical value of the results of my investigation will not be out of place. A study of the casualty statements clearly shows that although thinner trees may be cut fairly low, thicker trees must be cut

sufficiently high, if heavy casualties are to be avoided. Similarly, the hotter and drier the climate the higher should be the stumps. In this connection it is interesting to note that the general tendency of leaving high stumps when felling thick trees, which is always discouraged in a coppice-area, is just what should be encouraged when pollarding *anjan*. At any rate this is what the results of the experiment lead us to believe.

Finally, at what definite height a tree of a particular girth ought to be pollarded; or what should be the girth and height of the ideal stump, are questions which our investigation is unable to answer. Further investigation, on a much larger scale, alone will enable us to determine this. As I have already pointed out we shall not be justified in judging the *combined* effect of the two variables from the few measurements that we have got for each combination. Nor can I think of any method by which a correlation between the two variables could be established and thus the contribution of each factor to the growth of the shoot determined. Some idea can be had of the joint effect of the two factors—girth and height—on the mortality of the stumps, by adding the mortality percentages for each. But I am doubtful if much reliance can be placed on results so obtained.

BALAGHAT,
7th February 1931.

SAVIOURS OF THE FORESTRY MOVEMENT.

(THE PLANTING OF NEW SPECIES.)

By "Fagus."

During the first 30 years of the present century interest in forestry has greatly increased. Education in the subject has progressed by leaps and bounds and a new "forestry spirit" is being gradually inculcated into landowners and managers of land which cannot fail to benefit the movement as a whole. The most outstanding change, however, has been regarding the species planted, and although it is as yet too early for definite statements to be made as to the wisdom of this change, sufficient time has elapsed for criticisms to be made based on a foundation of fact rather than surmise.

For very many years the English forester has pinned his faith to certain species of tree; amongst hardwoods oak, ash and beech and amongst conifers Scots pine, Norway spruce and larch. In spite of that innate conservatism characteristic of the race, especially those members of it dealing chiefly with rural matters, it is a curious fact that a new species of tree acts rather like a candle to the moth—they must plant it. Had it not been for this fever in the past it is more than possible that larch canker would have been practically non-existent in the country.

In the middle of the eighteenth century the potentialities of larch as a really valuable forest tree were discovered. It grew quickly, was saleable at all ages and appeared perfectly healthy. As a result everybody planted it, regardless of soil or aspect. Hundreds and hundreds of acres of larch trees growing in unsuitable places and, naturally, thoroughly weak and unhealthy, resulted in the introduction of a disease now regarded as one of the greatest forestry menaces that exists. Known to foresters about the year 1800, by 1840 it was quite common.

During the present century various substitutes for the old-time conifers have been introduced. Prophecies based on their performances in their native country have been widely broadcast, and they have been

hailed as the saviours of the forestry movement in this country. It is probable that no more sudden and complete change of policy has ever been recorded in the forest history of any country—a change largely from hardwood to softwood and from one conifer to another. Instead of Scots pine we have Austrian pine; instead of European larch we have Japanese; and instead of Norway spruce we have Sitka. Finally, as an entirely new introduction we have the Douglas fir.

All these trees have been for many years in the country, in some cases having been planted as forest trees. As really serious competitors against the older species they do not date back more than 25 or 30 years. The mistake that is being made with these trees is excessive haste. Everything is experimental until its value has been proved, and these trees are still experimental and must be for many years to come. In spite of this obvious fact thousands of acres are being planted up with them, and in some cases good quality hardwood soils have been cleared and planted with conifers.

The cause of this extensive planting of new species is a very dangerous slogan which is being used by the boosters of exotic species of this type. This slogan is: "Quick returns and large profit." It is based on the unassailable fact that the earlier a crop is felled the higher the percentage return and *vice versa*. That is to say, a crop felled at 40 years may mean a percentage return on investment of 7 per cent., whilst if left to stand for another 30 years or so the investment may only be worth 3 per cent. or even 2 per cent., although the gross return is five or six times as great as that realised on the earlier sale. This is due to the machinations of that evil genius of forestry known as "compound interest." There is no doubt that, theoretically speaking, calculations by compound interest are sound; but it is as well that those who planted oak for shipbuilding in the early eighteenth century did not understand it. If they had we should now probably all be speaking French.

In order to keep pace with the increase of interest, production of timber must be rapid and with that idea in view bulk has been set as the standard of quality. This bulk naturally must be rapidly produced. That it can be done in this country is proved by figures obtained by the Forestry Commission. The following are a few examples:—

Species.	Age.	Volume per acre.	County.
		C. ft.	
Douglas fir	12	2,045	Devon.
Do.	28	4,309	Somerset.
Do.	55	8,160	Glos.
Sitka spruce	18	2,780	Somerset.
Do.	26	4,630	Dumfries.
Do.	41	5,745	Kincardine.
Japanese larch	15	2,360	Ayrshire.
Do.	16	2,055	Berwick.
Corsican pine	22	2,455	Somerset.
Do.	47	6,635	Carnarvon

Quality I. Sitka spruce is estimated to give 9,350 c.ft. at 50 years, against 6,760 c.ft. for Norway spruce. Japanese larch at 30 years gives 3,200 c.ft., against 2,900 c.ft. for the European variety. Corsican pine yields 5,050 c.ft. at 50 years, against 3,530 c.ft. for Scots pine at the same age. The estimated yield of Douglas fir at 30 years is 5,130 c.ft. and at 50 years 7,900 c.ft. (High as these figures seem they cannot compare with those quoted by an American authority for Californian redwood, which on Quality I areas in the U.S.A. is estimated to produce no less than 17,900 c.ft. at 50 years.)

These figures are undoubtedly attractive, especially to those anxious to turn their money over quickly. There are, however, two essential factors which must be taken into consideration, the first being quality. Quality is bound up with strength, especially the power of resisting pressure applied at right angles (*i.e.*, joists and beams). Now it is a recognised fact that the strength of coniferous timber depends largely on the rate of growth, and slow grown timber is stronger than that more quickly grown. The reason for this is as follows: The annual growth is made up of two zones of wood, that put on in the spring and that put on in the summer. Spring wood contains large cells and passages necessary for the passing of food supplies, and is therefore relatively weaker than the denser, heavier summer wood. The average width of the zone of summer wood is, as a rule, fairly constant, and in a wide ringed specimen the width is nearly always found to be due to an excess of growth in the weaker spring wood. Wide rings of spring wood generally mean early growth, a process definitely opposed to the normal growth of the average conifer, which has, as a rule, a very short growing season.

The average good quality Douglas fir now coming to this country will be found to have a far larger number of annual rings to the inch than the home-grown type, first qualities of which must average only about five rings per inch in order to keep up the growth necessary for obtaining the 7,000ft. and 8,000ft. estimated for per acre at 50 years of age. Such timber must be comparatively weak, and whilst its weakness is not so obvious where pressure parallel to the vertical axis of the tree is the chief strain (pitprops), for long beams, etc., its value will not be very great.

From these facts the conclusion is drawn that rapid production of bulk as a standard of excellence is not necessarily sound, and that the inferior quality of such timber when placed on the market will merit only such a price as will enable our older native timbers to become an equally lucrative proposition foot for foot.

Whilst it is admitted that highly scientific forest management and calculation are excellent things and assist progress, one must not overlook the fact that British estate forestry is more or more or less peculiar to the country, and while a change must come, and is coming, one should proceed with caution. At the present time we are—to misquote—in danger of being overcome "by the exuberance of the verbosity of science"—a science working on a basis of large areas and comparatively few figures. If the

Government wish to work on a large scale, and more or less in the dark, they should be allowed to, and if there is a bill at the end, it is far better to foot it as a nation than as an individual.

Regarding actual experience of the new trees obtained in the last half-century or so, one well-known point stands out clearly, and that is the general growth from a purely silvicultural aspect. Provided the soil is good and the climate kind it is not difficult to introduce a species as specimen trees, or even as forest trees on a small scale. It is only when the trees are planted very extensively, and not always too wisely, that trouble begins, and young trees may do well while older trees develop troubles unknown in the pole wood stages.

Douglas fir is a typical example. While this tree has been growing as a forest species for many years now, it is not so long ago that *Chermes Cooleyi* was found attacking the foliage of young trees. The increase of this pest has been rapid, and while argument continues as regards its potentialities as a definite menace to the species there seems to be little doubt that a severe attack results in a definite check to growth—a most undesirable thing. A disease similar to the larch canker is also increasing among trees of this species, *viz.*, that known as the Phomopsis disease.

Japanese larch appears to be more or less free as regards fungal disease, although it is also attacked by Phomopsis. Its resistance to larch canker has up to the present been a notable point in its favour. As to growth, however, although it grows more quickly than the common variety at first, it appears to be caught up later on. A somewhat disquieting fact regarding this species has been recently brought to light, and that is that after the twentieth year or so the leading shoots acquire a tendency to spiral growth, which must eventually affect the strength of the timber.

Corsican pine has done well silviculturally when once established, but is well known as a most difficult tree to grow in its early stages, and replacements of up to 50 per cent. among young trees are far from rare. In such cases a high initial cost will neutralise the returns from a considerable quantity of timber.

Destructive criticism is, of course, easy and no one will deny that in many cases the planting of these exotics has and will prove successful in the long run, but one cannot too greatly stress the point that they are at present purely experimental and without sufficient proof of their potentialities as a commercial proposition on a large scale. We do not know yet what the price of these timbers on a large scale will be. It may be that they, or some of them, will be worth considerably less on the market than our established trees.

Finally, it is to be hoped that the following quotation from Judges (X, 14) will never apply to those who would turn the old deciduous woodland of England into a coniferous forest: "Go and cry unto the gods you have chosen; let them deliver you in the time of your tribulation."

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NATURAL REPRODUCTION OF PYINGADO (XYLIA DOLABRIFORMIS) AFTER A GOOD SEED YEAR.

BY H. R. BLANFORD, O.B.E., I.F.S., CONSERVATOR, HLAING CIRCLE.

Natural reproduction of *pyingado* is abundant in some forests especially where fire protection has been successfully established for a number of years. Walsh's regeneration improvement fellings starting in 1912 in the Minhla and Mokka Reserves, Tharrawaddy Division, have proved that this reproduction can be established by fire protection, gradual removal of the overhead cover and cleaning.

Seed years of *pyingado* are somewhat irregular. Although there is usually a certain amount of seed available in most years, a good seed year occurs only every 3rd or 4th year in any particular locality. The year 1930 was a particularly good seed year throughout the Hlaing Circle and the opportunity was taken of studying the natural reproduction following the seeding.

Pairs of plots, 2 chains x 2 chains, were laid out in Okkan Reserve (Insein Division), Mokka Reserve (Tharrawaddy Division), Kangyi Reserve (Zigon Division) and Bwet Reserve (Prome Division). The type of forest was mainly moist upper mixed deciduous, though 4 plots in Kangyi were in lower mixed deciduous. One plot in each pair was weeded twice, once in June and again in August. Countings were made on a 1 square chain in the centre of each plot in June and again later. Unfortunately

the date of the second counting did not coincide in all divisions the plots in Mokka Reserve being counted in August, those in Bwet Reserve in September and in Okkan and Kangyi Reserves in October.

The following shows the results of countings, the results being multiplied by 10 to give figures per acre:—

Locality.	No. of *pyingado* seedlings per acre at first count.	No. of surviving *pyingado* seedlings per acre at second count.	Percentage of survivals.	Remarks.
A. Weeded plots.—				
Okkan ...	30560	22600	74%	High per cent. casualties due to very low heavy cover.
Mokka (i) ...	3700	3630	98%	
Mokka (ii) ...	5000	4760	95%	
Kangyi (i) ...	4510	3390	75%	
Kangyi (ii) ...	5830	4970	85%	
Bwet (i) ...	4930	4740	96%	Also 13 older seedlings.
Bwet (ii) ...	36010	34070	95%	
Average ...	12934	11166	86%	
B. Unweeded plots.—				
Okkan ...	32070	26880	84%	
Mokka (i) ..	3500	3350	96%	
Mokka (ii) ...	3500	3080	88%	
Kangyi (i) ...	2850	1870	66%	
Kangyi (ii) ...	3460	2120	61%	
Bwet (i) ...	1850	1730	93%	Also 6 older seedlings.
Bwet (ii) ...	7050	6140	87%	
Average ..	7754	6453	83%	

Omitting the plots in which the numbers of seedlings are very large and unduly bias the results in all other plots, the figures are :—

A. WEEDED PLOTS.

No. of seedlings at first count, per acre.	No. of seedlings at second count per acre.	Percentage of survivals.
A. Weeded plots.—		
4794	4298	90%
B. Unweeded plots.—		
3702	3048	82%

The growth of seedlings in the weeded plots showed slightly more vigour than in the unweeded plots, but the difference in percentage of survivals hardly seems to justify the expense of weeding.

The results show that natural reproduction of *pyingado* after a seed year is abundant and that a considerable percentage survives through the greater part of the first rains. The greatest danger to the seedlings is probably the first hot weather and it was proposed to fire protect all the plots formed and lay down further plots to compare the results of early burning and an ordinary hot weather fire on the percentage of survivals. Unfortunately the recent troubles in Tharrawaddy have rendered it impossible to fire protect all the plots, but those that have not been fire protected will be burnt early.

THE ANDAMAN MARBLEWOOD.

BY R. N. PARKER, I.F.S., FOREST BOTANIST.

The Andaman marblewood is commonly said to be produced by *Diospyros Kurzii*, Hiern. Parkinson in "A Forest Flora of the Andaman Islands" points out that this was probably due to the

botanical specimens and the corresponding timber specimens becoming mixed. He refers the Andaman marblewood to *D. oocarpa*, Thw. For several years it has been known that this identification is also incorrect and efforts have been made to obtain adequate botanical material from forest officers in the Andamans. These efforts have not been completely successful, in fact they have only resulted in procuring good fruiting specimens and the female flowers are still unknown. It seems evident, however, that the tree is an undescribed species and as it is desirable that it should not continue to go under an incorrect name I have described it below.

I have been in considerable doubt as to whether the plant is a Maba or a Diospyros. Parkinson's specimens show 3-merous flowers which indicate Maba but does not exclude Diospyros Parkinson *l. c.* says flowers 3-4-merous but I have not been able to verify this. The very great similarity of this species to *D. oocarpa*, Thw. and the arrangement of the stamens which can be matched in Diospyros but not in Maba seem to show that Diospyros is the correct genus.

This species is distinguished from *D. oocarpa* by the stamens being inserted at different levels in the corolla-tube and not all at the base or hypogynous. Also by its seeds with ruminate endosperm and perhaps also by the shape of its fruits. In *D. oocarpa* the fruits are said to be ovoid-oblong or ellipsoid, which they are also in the Andaman marblewood when not fully ripe, but when mature they are globose or even slightly broader than long.

This species belongs to the section Melonia of Hiern's Monograph of the Ebenaceæ in Trans. Camb. Phil. Soc. XII, i, near *D. hirsuta* and *D. mespiliformis*.

Diospyros marmorata, R. N. Parker sp. nova. *D. oocarpa*, Thw. persimilis sed stamina superiora medio tubi corollæ inscerta et seminibus albumine ruminato.

Arbor, ramuli tenues glabri. Folia alterna 7—11 cms. longa, 2·5—6 cms. lata, ovata vel elliptica, integra, acuminata, basi pleurumque rotundata, coriacea, glabra, costa media supra depressa, nervis lateralibus utrinque circa 9, supra inconspicuis

Ganga Singh, del.

Diospyros marmorata, Parker.

subtus prominulis, petiolo circa 5 mm. longo supra caniculato suffulta. Flores masculi axillares 3-4 brevissime cymosi, pedicellis calycibus corollisque extra minute adpresse pubescentibus. Pedicelli 4-5 mm. longi. Calyx 5-6 mm. longus, tubulosus 3-dentatus. Corolla 12—14 mm. longa, lobi 3, elliptici, 7 mm. longi, 3 mm. lati, contorti, dextrorsum obtegentes (ab exteriori spectanti). Stamina 12, quorum tria prope basim, sex paullo altiora et tria medio tubi corollæ inscerta. Antheræ 2 mm. longæ, apiculatæ, sparse hispidæ. Ovarii rudimentum deest. Fructus 3 cms. diam. globosus lævis, epulposus, juventute 6-locularis, calyce haud mutato suffultus, 3-spermus. Seminis albumen ruminatum.

Andaman Islands: Parkinson 593, 740. Dehra Dun Herb. Nos. 46497—46499 and 50622.

NOTES ON PINUS GERARDIANA.

By R. Maclagan Gorrie, D.Sc., I.F.S.

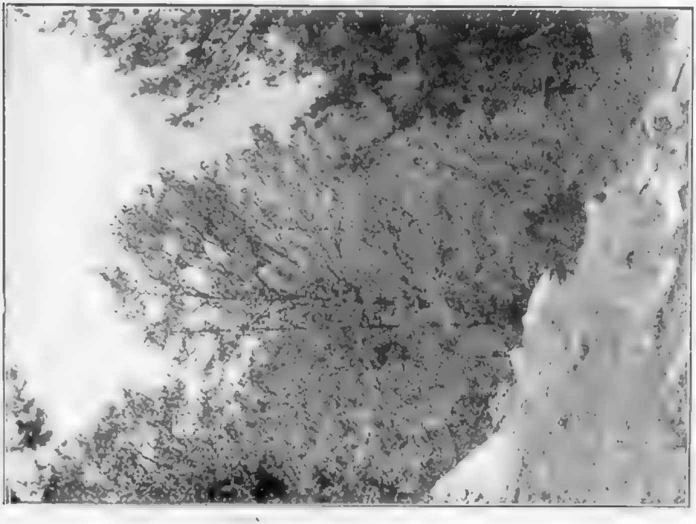
The source of the *neoza* or *chilgoza* nuts of the Indian bazaar is a pine tree which flourishes only in the arid inner valleys of the North-West Himalaya. The distribution of this tree, *Pinus Gerardiana*, Wall. is very peculiar, for it is found in Afghanistan and Baluchistan, and again in a more easterly group in the upper valleys of the Ravi, Chenab and Sutlej, and in inner Garhwal, but it is absent in the Kagan and Jhelum valleys throughout a wide area which lies between the first two groups.

Where it first appears along the valley bottoms of these inner hills, it replaces *Pinus longifolia* as a low-level pine where the full effect of the monsoon is exhausted and the annual rainfall of about 30″ is roughly half of winter snow and half of summer rainstorms. In such localities it is confined to the hottest and rockiest aspects below 8,000 feet, while kindlier slopes are occupied by deodar, *Pinus excelsa*, *Quercus incana*, and *Quercus Ilex*. As the country gets drier and the rainfall of 20″-30″ consists more and more of winter snow, the *neoza* extends uphill and occupies the better aspects, until towards the arid limit of tree growth on

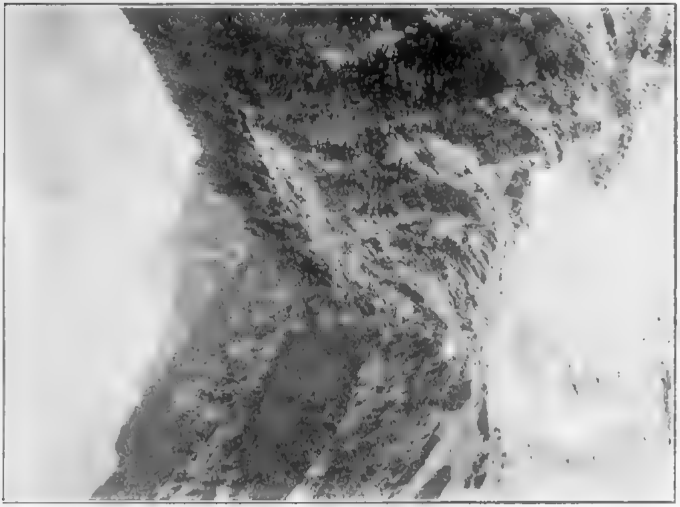
the Tibetan border, with a precipitation of 10"-15" almost entirely of winter snow, this pine runs right up to 11,000 feet. In such places the elevational belts of vegetation so characteristic of the moister outer hills are broken down, and the last remnants of tree growth, chiefly deodar, *Pinus excelsa*, *Pinus Gerardiana*, *Fraxinus xanthoxyloides* and junipers, are found huddled together on the more sheltered slopes, irrespective of their previous relative positions. Between these two extremes the *neoza* frequently forms large belts of pure forest, mixed in the upper part with deodar.

As a timber tree *Pinus Gerardiana* is not of much consequence, but this is due not to any great defect in its wood but to the fact that wherever it occurs, timber of better species such as deodar and blue pine is available. Actually the food value of the nut crop is considerable in the arid districts where it occurs, and this is an obvious reason why the tree should be preserved wherever possible. It is, therefore, used in construction work only where the better conifers are not available. It yields a timber somewhat similar to *chir* pine in strength and appearance, but rather coarser and more resinous. It occurs commonly as a tree of 50 to 60 feet in height and 6 to 8 feet in girth, the largest recorded being 70 feet high and 15 feet girth, noted by Stebbing from Shingar on the Afghan border. Tapping experiments have been carried out in the Sutlej Valley, and the resin yield is quite good, but the very short summer season and the difficulties of transport in such inaccessible districts render it unlikely that it can ever be tapped commercially.

In these arid inner valleys cereals are scarce, and the *neoza* nuts form a staple food. In good seed years there is also a brisk trade in exporting the surplus supply to the nearest market, the price varying from 4 to 12 annas per seer. The seed for use as food is extracted from the cones while these are still green by roasting them in an open fire until they open up. Considerable damage is done to the trees during cone collection, as branches and twigs are ruthlessly torn down. The right to collect *neoza* seed is admitted freely in most forest settlements, so that even



Typical *neoza* forest showing practically bare forest floor with occasional tufts of *Artemisia maritima*, *Thymus Serpyllum*, and *Dianthus angulatus*, and very occasional bushes of *Lonicera hypoleuca*.



The Teti Gad, which runs into the Sutlej from the Spiti watershed. On the right the cooler N. W. aspect has deodar and *neoza* in about equal proportions up to 8,000 feet where the deodar becomes pure. On the S. E. hotter slope on the left there is a pure *neoza* belt, opening out to scattered trees on the drier screes.

where the forests are reserved, there is little chance of cones surviving in sufficient quantity to yield a good seed supply for regeneration. Any ripe seed which reaches the ground has a lot of eager enemies waiting for it, because birds, rats, squirrels, monkeys and insects all take their toll of such sound food.

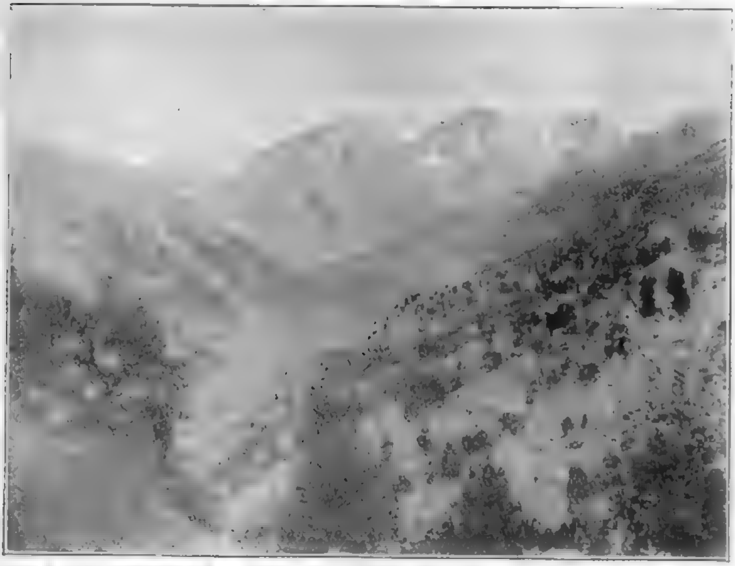
As one would expect in such arid soil, the seedling develops a long tap-root. It is apparently a light-demander, as it seldom comes up directly under *neoza* mother trees. It thrives well, however, under a moderately dense deodar canopy, and in heavily browsed areas it pushes up through dense bunches of scrub such as *Astragalus* and *Ephedra*. There is quite a marked tendency towards an alternation of species between the deodar and the *neoza* along the bottom of the dry-zone deodar belt, where one constantly finds regeneration of one or other coming up in the shade of larger trees of the second species, while each avoids the shade of its own kind.

The humus layer in such forests is a very thin scattering of conifer needles. The ground flora is very scanty and of a xerophilous type which provides very little in the way of leaf-fall; in fact of leaf-mould in the usual sense there is none. The exposed soil is very dry and friable, and with so little to bind its surface it is peculiarly liable to erosion from the fierce and sudden rainstorms which are so common in the inner hills throughout the spring and summer. The best soil cover here proves to be *Quercus Ilex*, for in addition to a thick evergreen canopy, it has a bushy root system which anchors the surface well. Unfortunately this oak is invariably lopped heavily for fodder, and in many places it is dying out, leaving bare ground which quickly becomes eroded down to rock surfaces on which even the *neoza* pine cannot be expected to persist. The *neoza* undoubtedly does a useful work as a soil protector over large areas of the inner hills which, without its help, would be dreary expanses of naked rock. It thus forms one of the outposts of the forest, and a study of its plant associates gives interesting sidelights on the ecology of xerophilous forest types.

In the Sutlej Valley north of latitude 31°30′, *Quercus Ilex* occupies most of the cooler southern bank at low levels, but it is seldom found to any extent on the hotter aspects. *Pinus Gerardiana* on the other hand is equally common on both flanks, though on the hotter side its optimum lies quite 1,500 feet higher and it is reduced to a mere bush on the hot cliff faces of the valley bottom. Under Ilex oak the common bushes are *Plectranthus rugosus, Caragana brevispina,* and *Abelia triflora*, other common plants being *Salvia glutinosa, Cynanchum Roylei* and *Verbascum Thapsus.* Below this Ilex oak belt along the valley bottom is a curious type of scrub in which plants of the outer foothills such as *Olea cuspidata, Zanthoxylum alatum* and *Capparis spinosa* are mixed with *Fraxinus xanthoxyloides, Artemisia maritima,* and occasional Ilex oak and *neoza.* The presence of these species from the semi-tropic outer foothills testifies to the extreme heat which is generated in the rocky gorges of the inner hills.

In the pure *neoza* forests there is a very scattered bush growth of *Fraxinus xanthoxyloides, Lonicera hypoleuca, Colutea nepalensis, Daphne oleoides* and *Artemisia maritima,* while herb growth is reduced to very occasional tufts of the sea-pink (*Dianthus angulatus*) and wild thyme (*Thymus Serpyllum*). As conditions become more and more arid the xerophilous cushion scrub of the alpine zone comes downhill, *Cotoneaster microphylla, Juniperus communis* and *Ephedra Gerardiana* being common.

Under the *neoza*-deodar mixtures again, the shrub and herb growth gives a very clear indication of the degree of dessication. In the more sheltered hollows there is a survival of the typical deodar flora such as jasmine, rose, brambles, *Thalictrum, Lilium podophyllum, Polygonatum multiflorum, Astragalus chlorostachys, Rubia, Galium,* and *Dioscorea.* Drier slopes which are still capable of carrying quite good deodar trees amongst the *neoza* and oak have a much heavier shrub growth of *Abelia, Lonicera quinquelocularis* and *hypoleuca, Artemisia vulgaris* and *vestita, Indigofera, Desmodium, Microglossa,* and *Berberis,* with a herb growth largely made up of coarse Composites such as *Senecio, Aster, Anaphalis* and *Lactuca.*



The arid valley of the Ropa Gad which drains from the Manirang Pass on the Spiti border. In this area the forest belt consists of pure *neoza* from 8,000 to 9,500 feet with a mixture of deodar, blue pine and *neoza* above this.

The Tidong Gad valley bottom at 8,500 feet showing the stony scree nature of the forest slopes. In such areas the *neoza* can definitely be said to act as a nurse for deodar seedlings. The apparent deodar "seedlings" in the foreground are sprouts from battered tree relics in the path of a snow-slide.

A further advance in dessication, with a tendency for the now stunted deodar to give place to pure *neoza*, is marked by a very scattered shrub growth of *Lonicera hypoleuca*, *Artemisia maritima* and *Roylea calycina*, while in the herbs the rank Composite type gives place to the scattered tufted growth of thyme and sea-pink already noted, along with *Nepeta supina* and *Polygonum paronychioides*. The only common annuals here are *Myosotis*, *Cynoglossum*, *Sisymbrium*, *Leptorhabdos*, and a balsam, *Impatiens brachycentra*, which shows a curious divergence from the usual moisture-loving role of the balsam family.

Another stage towards aridity is marked by an increase of *Ephedra* at the expense of *Artemisia maritima*, while apart from a few larger bushes of *Colutea*, *Daphne*, *Lonicera hypoleuca*, *Ribes orientale*, and *Prunus Jacquemontii* and *prostrata*, the vegetation in the open *neoza* stands of the Tibetan borderland is largely of the prickly cushion scrub type made up of *Potentilla rigida* and *eriocarpa*, *Caragana Gerardiana*, *Lonicera spinosa* and *obovata*, and several *Astragali* such as *A. polyacanthus* and *A. leptocentrus*.

Although all the wild vines prefer a much damper type of forest, the cultivated grape shows a close affinity with the *neoza*, for the distribution of this pine in the Sutlej Valley corresponds exactly with the area in which vineyards flourished prior to the appearance of a disease which ruined the Kanawar vine industry about 1860. Unfortunately this did not lead to any increase in sobriety, for John Barleycorn and fermented apricot juice were promptly brought in as substitutes!

EXTRACTS.

LECTURE ON THE FOREST GEOGRAPHY OF BURMA.

(*From an Economic Standpoint.*)

(BY C. W. SCOTT, D.F.C., I.F.S.)

GENERAL.

In approaching this subject from an economic standpoint it is necessary to emphasize at once the supreme importance of teak. That unique timber is the foundation of the fame and value of the Burmese forests. The chief virtue of teak is its unrivalled steadiness and durability when exposed to weather, white ants and the various factors which produce decay, warping, shrinkage and other defects in less valuable timbers, especially in the conifers or softwoods of the temperate regions. Thus for ships' decks teak is supreme throughout the world because it stands up to heat and cold, sun and water better than any other timber.

It is unnecessary to consider those parts of Burma which are over 3,000 feet above sea level because broadly speaking they do not grow teak and their forests are unimportant,

RAINFALL AS THE KEY TO THE FOREST GEOGRAPHY OF BURMA.

Rainfall is the key to the forest geography of Burma. Soil and drainage are important factors but rainfall is the chief controlling influence. An annual rainfall map of Burma looks like a target with Mount Popa and the dry zone (Myingyan, Meiktila, Yenangyaung, Mandalay, etc.) as the bull's eye and successive rings of increasing rainfall arranged in concentric circles around the bull. Roughly speaking one may divide the whole country into three concentric zones.

(1) A central zone with an annual rainfall of 20 to 40 inches. In it there are no valuable forests. It is the well known "dry zone" of Burma.

(2) A middle zone with 40 to 80 inches of rainfall. The most valuable forests of the country occur here. Within a rainfall of about 50 to 70 inches

teak is at its healthiest and best. Pyinmana and Prome are typical of this region.

(3) An outer zone with 80 to 200 inches of rainfall. This is the most densely wooded of the three zones but the prevailing type of forest is evergreen without teak and hence of inferior economic value. There is a considerable overflow of teak from the middle zone into the less wet part of the outer zone, for example, in Toungoo, Pegu, southern Tharrawaddy and Insein; but the great evergreen forests of Tavoy and Mergui contain no teak.

For further information on this very interesting subject reference should be made to Dr. L. Dudley Stamp's monograph on the Vegetation of Burma (Thacker, Spink & Co., Calcutta, 1925) where there is an excellently simple and clear description in more detail.

THE FOUR CHIEF TYPES OF FOREST.

The important forests of Burma are of four very distinct types.

(1) Teak forest in which teak is the chief tree although it is only some 12 per cent. of the total crop. It is usually associated with *pyinkado* (*Xylia dolabriformis*) which in turn forms some 18 per cent. of the crop. Thus about one-third of the trees are teak or *pyinkado* and the remaining two-thirds are a very mixed assortment of some scores of species which are all at present far behind teak and *pyinkado* in value. A large part of teak forest is occupied by bamboos which help to keep the teak clean and healthy and are themselves of great domestic value. Good teak forest is found typically on hilly ground, not on plains. The central and northern part of the Pegu Yoma hill range provides the finest example of this type in the hill forests of Yamethin (Pyinmana), Prome, Tharrawaddy and Toungoo districts.

(2) *Indaing* forest in which the chief trees are *in* (*Dipterocarpus tuberculatus*), *ingyin* (*Pentacme suavis*) and *thitya* (*Shorea obtusa*). This is a dry type corresponding in some respects to the sal (*Shorea robusta*) forest which is one of the most valuable types in India and Nepal. The crop is much less mixed than in teak forest and bamboos are absent Level but not swampy ground is typical of this type. The best example is the forest on the east bank of the Irrawaddy between Katha and Bhamo.

(3) Evergreen forest in which the chief tree of present economic value is *kanyin* (*Dipterocarpus alatus*, *turbinatus* and allied species) although the crop is extremely mixed and some of the commonest trees are as yet scarcely ever used. This type reaches its finest development in Tavoy and Mergui where it occupies almost the whole of those districts apart from the small areas under cultivation.

(4) Tidal forest in which the chief trees is *kanazo* (*Heritiera minor*), the best firewood of Rangoon, often seen on sale there as round billets which a man can conveniently shoulder. This is a mangrove type confined to the tidal zone of the sea coast. It reaches its greatest extent in the Irrawaddy delta, south-east of Bassein. The floor of this forest is frequently under

seawater and the trees produce special breathing roots which grow up instead of down. The result is like a magnified pin cushion.

THE SEVEN MAIN FOREST AREAS OF BURMA.

There are seven main forest areas in Burma. They are as follows in descending order of economic importance:—

(1) The Pegu Yoma hills, producing 50 per cent. of the total annual outturn of Burma teak.
(2) The Upper Irrawaddy drainage, producing 25 per cent.
(3) The Chindwin drainage, producing 12 per cent.
(4) The Salween drainage, producing 7 per cent.
(5) The Arakan Yoma hills, producing 5 per cent.
(6) The South Tenasserim area (Tavoy and Mergui) producing no teak.
(7) The Irrawaddy Delta, producing no teak.

(1) THE PEGU YOMA HILLS.

This is much the most important forest area in Burma. It produces half the total teak outturn, including some of the finest quality. It is a compact, roughly rectangular block of forest, with its long axis north and south, lying parallel to and between the Irrawaddy and Sittang rivers. It begins some 35 miles north of Rangoon, close to Wanetchaung on the Rangoon—Prome Railway line, and runs north in an unbroken stretch for 200 miles until it ends on the edge of the dry zone opposite Yamethin town. Its average width is some 30 miles, of which roughly speaking 10 miles lie west of the Sittang—Irrawaddy watershed and 20 miles lie east of that same. Its area is thus 6,000 square miles, taking into account only the land reserved as permanent forest and belonging to the Government.

The Pegu Yoma is one of the most valuable forests in the world and Burma has every right to be proud of it, of the careful conservation of its timber and of the great teak industry which it supports. The chief aim of the Forest Department in managing this forest is to remove annually only the surplus of ripe trees and to leave undamaged the immature stock. Indeed to go further and as far as funds permit improve the immature stock by helping teak at the expense of less valuable trees. This of course is the fundamental difference between scientific forestry and mining. The forester like the farmer is dealing with a living growing asset which can be made to yield an annual return indefinitely. The miner is dealing with a wasting asset which is certain to be exhausted some day.

In the decade 1912–22 the Pegu Yomas produced 188,000 tons of teak annually and a surplus of Rs. 48,00,000 per annum, clear profit to Government after deducting all expenses of management. This was 60 per cent. of the total net forest revenue of the country. Expressed in sterling it is £360,000 per annum, a figure perhaps unequalled by any other single forest in the world, worked under the principle of a sustained yield without fear of exhaustion. This substantial sum went of course towards paying for the general administration and development of Burma. Without it the

expenditure on roads, hospitals, police, etc., would have been less or taxes would have been heavier. Moreover the expenditure by the teak firms and by the Forest Department on teak extraction and forest management represent a great asset to the local population around and in the Pegu Yomas.

There are probably few of the citizens of Rangoon who realize that this great forest lies at their door; that after an hour's run in a motor they could walk into this forest and travel north through it for 200 miles without coming out of the trees. Wild elephants, tiger, bison and rarer game still live within 50 miles of Rangoon. It is, of course, only yesterday, so to speak, that the fringes of the forest reached Rangoon itself. Within the memory of many still living a tiger wandered into the Shwe Dagon Pagoda and a leopard was seen between Mingaladon and Insein. The gap between the tigers of Tiger Alley and the streams of motors which now use that route into Rangoon is surprisingly short.

Scientific forest management in the Pegu Yomas was introduced by Sir Dietrich Brandis in 1856. Those who wish to know more about the subject are referred to "A Note on the Pegu Yoma Forests" (Superintendent, Government Printing, Burma, 1923) by Sir Hugh Watson, lately Chief Conservator of Forests, Burma.

(2) The Upper Irrawaddy Drainage.

This is not a compact or homogeneous area, but for simplicity one may group together the Irrawaddy and all its tributaries above the mouth of the Chindwin, that is practically the Irrawady drainage north of Mandalay, although the Mu and Namtu rivers join the main stream a little below Mandalay. A quarter of the total teak outturn comes from this area, including a considerable volume of teak from the Shan States brought down the Shweli and Namtu rivers. In the south the forest is dry whereas to the north it becomes moister and passes into evergreen without teak.

A rough boundary line can be drawn from Maingkaing in the Chindwin drainage through Mansi to Mawhun in the north of Katha District; thence to the mouth of the Shweli river and south-easterly to the higher hills. North of this line the forest tends to be evergreen rather than of true teak type. Teak does occur, sometimes plentifully, but sometimes only as old scattered trees surrounded by younger evergreen trees which prevent young teak growing up to replace the old trees. This shows that a great change in the nature of the forest has been taking place. A possible factor is the past wars which depopulated large areas and so reduced the amount of annual burning by fires from shifting cultivation (*taungyas*). This would tend to favour the evergreen species which cannot tolerate fire so well as teak.

South of the boundary line above described the forest is more definitely of the true teak type but much mixed with *indaing*. It becomes gradually drier southward and passes finally into scrub as the dry zone is reached. There is a very fine stretch of *indaing* of considerable economic value on the

east bank of the Irrawaddy from Shwegu to Kyannat. It covers 300 to 400 square miles and supplies much *in* timber to Mandalay. It occupies the flat ground of an old river shelf some 60 to 100 feet above the present Irrawaddy level.

(3) The Chindwin Drainage.

The Chindwin area repeats many of the features just described in the Upper Irrawaddy. The rainfall increases northwards and there is a corresponding change from scrub through *indaing* and dry teak forest to moister teak forest and finally evergreen. The Lower Chindwin produces some good teak but the quality falls off in the Upper Chindwin as one approaches the northern limit of the teak and the heavier rainfall in which evergreen trees thrive.

(4) The Salween Drainage.

The Salween river drains an immense area but its present teak outturn even including the Thaungyin and Ataran rivers is only 7 per cent. of the total for Burma. A part of its long course lies in the states of Karenni, east of Toungoo, where the forests have not been controlled or conserved by the Forest Department. The result is an object lesson in the evil effects of over-working. All the best teak trees have been taken and many years of rest and restriction will be necessary to restore the crop, if indeed some of it can ever be restored.

There is much limestone in the Salween and teak is not at its best on that soil. Also of course much of the Shan States portion of the drainage is too high above sea level to bear teak. At suitable elevations the teak tends to occur in a narrow belt above the level of the morning mists and below the level at which oak and *ingyin* replace teak. The river is often obstructed by rapids and rocks which make teak extraction much more difficult than on the Irrawaddy.

(5) The Arakan Yomas.

The Arakan Yomas produce only 5 per cent. of the total teak outturn as against the 50 per cent. of the Pegu Yomas. Indeed in all respects the Arakan Yoma forests are disappointing from an economic standpoint. Their greatest asset is the teak of their north-east slopes, in the Pakokku (Yaw), Minbu and Thayetmyo districts. This teak belt deteriorates in Henzada and ceases at the Bassein boundary. There is heavy evergreen along the crest of the Arakan Yomas and descending in strips and pockets into the valleys. Towards the south, in Bassein, this evergreen comes down to sea level and is an asset of some importance to the populous rice growing delta districts. These districts use considerable quantities of certain evergreen trees which are seldom or never used elsewhere in Burma where teak and *pyinkado* are cheaper and more plentiful than in Bassein.

As regards the western slopes of the Arakan Yomas, that is Arakan (Akyab, Kyaukpyu and Sandoway districts), the outstanding fact is that enormous areas are practically monopolized by a peculiar bamboo called

kayin (*Melocanna bambusoides*) or *tabindaing* owing to its habit of throwing up stems singly and not in clumps like most bamboos. This *kayin* occupies the ground almost to the exclusion of trees. Arakan is its stronghold. There it is estimated to occupy 75 per cent. of the forest area. It overflows to a considerable extent into Bassein and Henzada and to a minor extent into Thayetmyo. It is an invader but the course and cause of its invasion are as yet unknown. It seems probable that shifting cultivation (*taungya*) by the Chin tribes has had much to do with the result which is deplorable as far as the forest is concerned.

There are proposals to use *kayin* bamboo for paper pulp and it is to be earnestly hoped that they will succeed. In some drainages there are large supplies of bamboo not wanted for domestic purposes or *taungya* cutting. If these surplus supplies could be put to use it would be of great benefit to Arakan and everyone concerned.

(6) The South Tenasserim Area (Tavoy and Mergui).

This is an immense forest area, greater in extent than the Pegu Yomas but practically speaking devoid of teak. The two commonest trees are *taung-thayet* (*Swintonia floribunda*), a close relation of the ordinary mango tree, and *gangaw* (*Mesua ferrea*), neither of which is as yet used or likely to be used for some years to come. *Kanyin* (*Dipterocarpus* spp.), which in India is called *gurjun* and in the Phillippine Islands is called *apitong*, is the commonest timber extracted. *Thingan* (*Hopea odorata*), *kyathnan* (*Carapa moluccensis*), *thitka* (*Pentace burmanica*) and many other timbers scarcely known in the teak zone of Burma are also extracted but they are not really plentiful.

In the past the potential value of these evergreen forests was overestimated. It is now known that they compare unfavourably with the forests of the Andamans and still more so with the evergreen forests of the Philippines where the crop is much heavier and includes a very much higher percentage of valuable timbers.

The South Tenasserim forests are valuable as a reserve against the future needs of Burma. The increase of population and the exhaustion of the unclassed forests, that is those not set aside as forest reserves to be kept permanently under trees, will probably create a market even for *taung-thayet* in the course of time, especially as it lends itself to extraction by floating and to creosoting.

The remarks on bamboo pulp in Arakan apply also to South Tenasserim where there are large surplus supplies of *waya* bamboo (*Oxytenanthera nigrociliata*) running to waste.

(7) The Irrawaddy Delta.

This area consists entirely of tidal forest and of course produces no teak. The chief timber is *kanazo* (*Heritiera minor*), known as *sundri* in Bengal, an almost unrivalled firewood burning with very little smoke and approximating in heating value to coal. So far in Burma it has been worked only as firewood and not as timber. In the Bengal *sundarbans* the same

tree occurs but of smaller size. There it is highly prized as timber in spite of being hard to saw and difficult to extract owing to the mud and innumerable tidal creeks of the forest in which it grows. It is probably only a question of time before *kanazo* is worked in Burma also as timber and not merely firewood. The Irrawaddy delta forests are relatively close to Rangoon and easily accessible by water. Extraction of the heavy *kanazo* logs, however, presents unusual problems which will not be solved until the demand is keener.

SUMMARY.

(1) Rainfall is the chief controlling influence on the forest geography of Burma. The best teak forests occur where the annual rainfall is about 50 to 70 inches.

(2) The three chief teak areas are the Pegu Yomas, the Upper Irrawaddy and the Chindwin, producing respectively 50, 25 and 12 per cent. of the total outturn from Burma.

(3) The Salween drainage and the Arakan Yomas are of minor economic importance.

(4) The main evergreen forests of southern Burma are a useful reserve against future needs but are at present of minor importance, their commonest timbers being unsaleable.

(5) The tidal forests of the Irrawaddy delta are at present worked only for firewood but contain good timber.

(*Burma Geographical Journal, February 1931.*)

FORESTRY IN MADRAS.

(By R. D. Richmond).

Mr. R. D. Richmond, Chief Conservator of Forests, delivered an interesting and instructive address on 'Forestry in Madras' on the 9th December, 1930, at the weekly meeting of the Madras Rotary Club held at the Gymkhana Buildings.

Mr. Richmond began by saying that it was not an easy thing to fix the date on which forestry was first regarded seriously in this Province. A Forest Department was first formed in 1856 but for a very long time before that date the forests of South India were of considerable importance in connection with the supply of teak for the Bombay Naval shipbuilding yards and the gun carriage factory. But as they went on and no thought having been given to the future, teak became hard to obtain and it was this increasing difficulty which led in the forties to the commencement of the famous Nilambur teak plantations in Malabar. These plantations probably now constituted the most valuable forest property in the world.

The speaker then paid a tribute to the work of Dr. Cleghorn, Jago and Turnbull in the Department in its earliest years. It was in 1881 that the Forest Act was passed and he believed that a forest conscience was of slower

growth in India than it was in other parts of the Empire which had adopted a forest policy long after India had done so.

Proceeding, Mr. Richmond said :—

Following the pre-occupations in respect of finding teak for the Dockyards was a period of activity in setting aside areas for the supply of wood fuel to the Railways and it is curious that it was not realised until much later that the public at large should be protected in respect of their timber fuel and other demands upon the forest. This at last realised, there was feverish activity, so far as a very limited staff allowed of, in reservation, survey and settlement which continued until the early years of this century. Some forestry was practised in the meantime, makeshift arrangements were in force for the provision of produce and the realisation of revenue, but the main problems had not yet been tackled. Principally in connection with fuel supplies for the railways, but also for other purposes, considerable areas of casuarina plantations had been formed to be given up some twenty years ago as it was thought that this activity might well be left to private enterprise, while the beautiful woods of the Nilgiris had been saved from destruction by the formation of plantations of exotic species. This is perhaps the most striking item in the work of the early days of the Department. The æsthetic value of the "sholas" remains and the Nilgiri towns enjoy a more ample and cheaper wood supply than any other hill stations in India.

An indicative of the direct value of forests to a country it may be mentioned that the gross revenue so derived over the whole of India and Burma in 1926-27 was four and a half millions sterling and the surplus revenue was two millions. From the earliest days the forests of Madras have paid their way. In sixty years there has been only one in which revenue has not covered expenditure and the forests of the Presidency have, in some fifty years, produced a total net revenue of 252 lakhs. The surplus has never been very striking; Rs. 25½ lakhs in 1919-20 was the highest, when there followed a number of comparatively lean years, one reason for which was the considerable rise in pay and wages following the war. But in the last two years there has been a very marked recovery, to a surplus of over Rs. 15 lakhs and although nothing very spectacular may be expected this surplus, 130 times greater than it was 50 years ago, will steadily increase, as will the value of the forests, not only as a money-making factor but as a many-sided and invaluable asset to the country.

Fifty years is a short time in the life of a forest, but in that period much has been accomplished. A property, degraded by centuries of misuse, has gradually been improved and is being brought to a condition at which it can be made the fullest use of. It is commonly supposed that with the increasing use of metal the consumption of wood decreases. Such is not the case. The world's consumption of wood *per capita* is higher to-day than it was thirty years ago. Much, it is true, is devoted

to paper-making—the increased use of paper is a sign of expanding civilisation—and a world shortage of soft woods is predicted on this account; but as countries develop and a higher standard of living is attained, wood and more wood is required for better class dwellings and so on.

It is the duty of the Forester to see that the property entrusted to his charge is made the fullest use of, to ensure that the people are able to obtain their requirements with the least inconvenience and, above all, to see that the principle of the sustained yield is not deviated from. The forest represents the capital, what that forest puts on in growth in one year is the interest, which alone it is permissible to remove. But before it is justifiable to work a forest, it is necessary to know what kind of trees it contains and at what rate the trees grow, to devise the best methods of working with due regard to replacing the tree crop removed and to consider the difficulties of extraction and the prospects of marketing. It is only within the last few years that the staff, the means for doing this essential work, has been available, leading to the longest step forward yet taken in the development of forestry in the Madras Presidency. Similarly, steps have recently been taken to undertake silvicultural research, to ascertain by centralised enquiry and experiment how best and cheapest to establish crops of the large number of different kinds of useful trees which occur—the teak, the rosewood, the sal, the sandalwood and a host of others. Some of you here may not be aware of the importance of the sandal tree to this Presidency. As insignificant tree, a parasite on its neighbours, it is responsible for an annual revenue of some Rs. 10 lakhs and what with its ailments and vulnerability to theft is a source of perpetual anxiety. Among other post war efforts have been those towards utilising kinds of wood hitherto little used and working types of forest hitherto considered inaccessible—in fact research on an industrial side has been undertaken. Results, many of them of a negative nature, have been obtained, much useful information has been collected, but the value of the timber extracted is too low to cover the cost of extraction and the class of intensive working involved by the use of machinery is unsuited to the hill forests of the West Coast. But a promising method of working is now being evolved and profitable exploitation is in progress. On flat ground the elephant will beat the machine while on the hills, man-power has established its superiority over other motive agencies. Saw milling by Government agency has been tried and abandoned: it is probable that such enterprises should be left in private hands.

Another development of the last few years has been the supply of Railway sleepers, the number so supplied increasing annually. Not more than 44 per cent. of the sleepers used on the 40,000 miles of India's railways are of wood (I believe the total number of sleepers is some 63 million) and the use of metal is increasing, but there can be no doubt that the southern railways will always require wood to the full extent of the ability of

Madras to supply it. Unfortunately, a project to render the less valuable timbers suitable for use as sleepers by preservative treatment came to nothing; a plan for the experimental manufacture of three plywood, which is so largely imported, sharing the same fate.

The forests of the country are badly distributed; very naturally they are principally confined to the hills and to land unfitted for agriculture; costs of production are high, leads by railroad are long and timber imported by water is able to compete successfully in many places with that produced locally. And many of the main users of wood fail to appreciate the fact that our own teak is, if anything, superior to that imported from Burma (to a value of some Rs. 80 lakhs a year) while a large number of the other kinds of timber are suited for a number of purposes to which the more expensive teak is at present devoted.

Apart from timber, the forests supply the population with agricultural implements, fuel, leaves for manure, and grazing. Last year 20 million cubic feet of timber and fuel were exploited, and grazing at purely nominal fees—as low as 3 annas per cow per annum in some cases—was provided for nearly two million head of cattle. With the denudation of areas excluded from reservation and of the private forests, the demands upon the reserves become more and more intense and it is the aim of the Department to increase, so far as funds and staff permit, the productivity of the forests in its charge. The people must be afforded a legal means of obtaining what they require.

Something, too, has recently been done to improve the marketing of the great number of minor products—gums, canes, tanning and other barks, oils, flosses, fruits and so on—which the forests provide; while lac, the source of considerable revenue elsewhere, has now been introduced into several centres. But a great deal remains to be done. The mixed nature of the forests, the large number of species occurring and transport difficulties all operate to the disadvantage of forest industries such as match and pencil making and the manufacture of paper. It has been said that the bamboo of India and Burma are able to supply the world's need in paper and it has been shown that an admirable paper can be made from this source. Arrangements have been made for the supply of paper to a private company in the Presidency and it may be hoped that paper making from bamboo may soon be a locally established industry.

If some stress has been laid upon the financial and direct aspects of forestry it must not be supposed that the indirect benefits are not of the first importance. Without forests a country, particularly a tropical country, cannot exist. The reduction of countries to desert condition owing to the destruction of its tree growth has been apparent in many instances.

The effect of forests upon the water-supply of a country must be obvious, as is their function in the regulation of the run off, the silting of rivers and the prevention of floods. Unhappily the results of neglect

are slow in showing themselves, but one is personally aware of the gradual and progressive silting of the Godavari mouths, of silted rivers being unable to contain their flood water, of a river used not a century ago for floating our teak on its way to the Bombay dockyards no longer possible for such a purpose; while the repeated wash aways of the Nilgiri road and railway in the last few years are due to one cause only, as is the repeated interruption of the East Coast Railway over a number of years. The forests of Madras protect seven million acres (and the consequential revenue of cultivable land under major irrigative works alone). This aspect of forestry, and the need for afforesting important catchment areas, is generally overlooked and though its value in this regard is difficult to assess in rupees it is very great indeed. It is an aspect, which is in many respects more important than finance and it is this, which makes forestry essentially an affair for the State. The financial side is important—every forest must be worked to its fullest capacity and must be perpetuated, working must be on the most economical lines, the people must be provided with their requirements, but the other objects served by forests should never be overlooked.

The area of reserved forests now left in charge of the Forest Department is 15,500 square miles, so that the average area in charge of a district or division is as much as 550 square miles while some are of far greater extent. This is a more than sufficient task for any one man, even if considerably less than the 1,700 square miles I wandered round and round—unable to do much more—as one of my first district charges. Increases of establishment there have been, as a result of years of struggle, but the staff is on none too generous lines now, and when one recalls how difficult it is to protect the small confines or our own gardens, it is easily realised what is the task confronting a small protective staff expected to prevent theft from over 15,000 square miles, enclosed in 26,000 miles of boundary and in the immediate charge of only about 1,500 forest guards.

Forest education has not been forgotten. A school for the education of the lower ranks was instituted at Dehra Dun some fifty years ago. Until a few years ago the officers of the Department were trained in Europe first in France and Germany, and from 1887 in England; but there is now a course of training at Dehra Dun. A Forest College was established at Coimbatore in 1912 and is responsible for the training of the Rangers of Madras, the neighbouring Provinces and Indian States.

Time prevents mention of the æsthetic side of forestry, its appeal to the lovers of natural history, of the fauna and of the wild. The life of a Forester in India may be hard, he is faced with continued difficulties and discouragements, but few of us I think would choose a different career had we to start in life again.

With a vote of thanks to the speaker the meeting terminated.

(*Junglewallah*).

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TOURING UNDER DIFFICULTIES IN BURMA.

BY F. G. BURGESS, I.F.S., D.F.O., ZIGON DIVISION.

The average Forest Officer is usually looked upon as a "Jack-of-all-trades," and the following account of a tour in the Zigon Forest Division, Tharrawaddy District, Burma, during the Tharrawaddy rebellion, may be of interest to readers, showing as it does, the ability of Forest Officers to adapt themselves to unusual conditions. This article is not meant to be an account of the actual rebellion—of its causes and its effect on forestry in general—but it is necessary to explain briefly the general situation which necessitated the tour. The rebellion broke out on the 22nd December, 1930, and before Xmas day, one Gazetted Officer and three subordinates of the Forest Department had been killed. The trouble was at first confined to a small area in the Tharrawaddy Forest Division, but, spreading northwards, the whole of the division soon became involved. Zigon Forest Division, which adjoins Tharrawaddy Division in the north and is in the same Civil District, was not affected to any great extent, until action by the Military authorities caused the rebels to split up into small parties and seek fresh areas. It became evident, about the middle of January, that no forest works would be carried out in Tharrawaddy Division for some time, because, not only had the Division lost some fifty buildings which had been burnt by the rebels, but the services of its Officers and subordinates had been placed at the disposal of the Military and Police authorities as

guides and interpreters. The situation in Zigon Division at that time was fairly quiet, as no rebel party had been reported farther north than a village called Htanbingon, three miles north of the northern boundary of Tharrawaddy Division. In consultation with the Civil authorities, it was decided to make an attempt to complete girdling and measurement of teak in Zigon Division, which had been interrupted when all Forest Officers and subordinates were recalled to headquarters during the last week of December. (It should here be explained that the extraction of teak in the Tharrawaddy and Zigon Divisions is carried out for Government by the Myitmaka Extraction Division, which is staffed by Forest Officers and specially recruited Timber Assistants.) Other reasons for the tour were, (1) to restore confidence among the villagers living in the forest, and, (2) to alleviate the distress in villages which rely upon the Forest Department to supply work after the paddy reaping season ends. As so many Forest Officers and subordinates were on duty with the Military and Police forces, it was difficult to raise a Forest party that would be of sufficient strength to protect itself in the event of an attack by the rebels, especially as extra men would be required for guard and camp protection duty. Finally a combined party from Zigon and Myitmaka Divisions was raised, being made up as follows :—

Zigon Division.	Myitmaka Division.
One I.F.S. Officer.	One B.F.S. Officer.
Two B.F.S. Officers.	Three senior Timber Assistants.
Four Rangers.	One junior Timber Assistant.
Six Deputy Rangers.	One Ranger.
Four Foresters.	Four chaung-okes.
	Four chaung-gaungs.

(NOTE :—Chaung-okes and chaung-gaungs are equivalent to Deputy Rangers and Foresters respectively.)

Before leaving Tharrawaddy (which is the headquarters of Tharrawaddy, Zigon, and Myitmaka Divisions), all gazetted officers were issued with service rifles, and the party as a whole received 400 rounds of .303 ammunition, 500 S. G. cartridges for ·12 bore guns, and 150 cartridges for ·32 revolvers. The Officers

left Tharrawaddy on the afternoon of the 21st January, arriving at Zigon the same evening. Subordinates were then collected and final preparations made, which included the inevitable group photograph. In these preparations, the party was greatly assisted by the Divisional Forest Officer, Myitmaka Extraction Division, and by an officer of the Buffs, who was acting as Police Staff Officer, Tharrawaddy. Whilst at Zigon, news was received that rebels had been seen in small numbers at a place twelve miles due east of Zigon, and the Deputy Commissioner, who had arrived in the meantime, immediately arranged for twelve Military Police to accompany the party as an additional safeguard. A start was made from Zigon early on the 24th morning, eight motor lorries being used as the party had grown to a force of about sixty—a most formidable crowd, being armed with 20 service rifles, 24 shot guns and a dozen revolvers. The first journey was one of 24 miles, and was not without its incidents. First one cook was mislaid (he later turned up at camp in a pony cart), then the lorry drivers refused to proceed because the road was too bad. This necessitated the use of the Military Police—for demonstration purposes only of course—and the column continued on its way. Soon one lorry gave up the struggle, then another, and all had to be man-handled at one time or another. Eventually the column reached the Forest village of Kunsan where the first halt was to be made, and the rest of the day was spent in arranging the camp, guards, patrols, etc. The Forest subordinates entered fully into the spirit of the thing, and did their share of guard duties, challenging all and sundry, and refusing to allow anyone to approach without first giving the pass word. The villagers were warned of the danger of moving about at night without lights, and all were examined for the "galon" tatto mark, which was the badge of the rebels. The march was resumed the next morning, elephant transport replacing motor lorries, as the column had now reached the foothills of the Yoma mountains where only elephant paths existed. With the addition of 33 elephants and their 66 attendants, the column presented a most imposing appearance, the mere sight of which, would

have struck terror in the heart of any rebel. The march was carried out in correct Military style, with advance guard, main guard, and rear guard, and progress was necessarily slow. Sangyi forest village, the next halting place, was reached at 10-30 a.m., and the same procedure as to guards, examination of villagers etc., gone through as before. The next days' march brought the column to the village of Nyaule, from where it was possible to carry out the girdling of one compartment. It was here that the photograph showing the complete party was taken. A busy afternoon and evening was spent in arranging work for the morrow, the idea being to work with three parties, finish girdling the area in three days, and then push on to the next girdling camp, which was in very dry forest, and where the water supply problem for such a big party was expected to become difficult by the beginning of February. Three parties started girdling the next morning, there being two Gazetted Officers to each party, both of whom carried revolvers, and one a rifle. In addition, a subordinate armed with a double-barrelled gun, accompanied each party, chiefly for the protection of the back hammer man. One Officer was left on guard duty in the camp, whilst the Divisional Forest Officer himself supervised the work of all three parties. A full days' work was carried out, and the necessary accounts were being made out, when, about 5-30 p.m., a runner arrived from the Revenue Assistant, Zigon, with a message stating that a party of rebels had attacked Gamon Range headquarters, situated at Waing village, about 25 miles south of the camp. A rest house, the Ranger's house and office, a Deputy Ranger's house, and three Foresters' houses had been burnt, and the rebels were reported to be moving northwards, their objective being Bawbin, the headquarters of another Range. Another message was received at 6 p.m. (27th January), stating that Waing was attacked at 9 a.m. on the 26th, that the Range Officer and a party of 25 Karen volunteers were pursuing the rebels from the south, that another volunteer party had gone out from Zigon, and that the Deputy Commissioner had suggested that the armed Forest party should leave its work and march south to intercept the rebels' northward

move. A hectic evening followed the receipt of these messages. Accounts were made up, coolies paid off, elephants collected and tethered, extra guards posted, and arrangements made for an Officers' patrol to visit guards every hour. An early start was made on the 28th, the whole party being in high spirits at the thought of getting a chance of meeting the rebels. On the way a message was received from the Karen volunteer party confirming the news that the rebels were making for Bawbin, and that they (the Karens) hoped to get there first. At 12-30 p.m., the column reached Kunsan, having marched 12 miles, so a halt was made and the usual fortified camp prepared. During the afternoon, Forest villagers were sent off in the direction of Bawbin to gather what information they could, and in the evening the Revenue Assistant arrived from Zigon. From him it was learned that the volunteer party from Zigon had reached Bawbin before the rebels, and it was thought that the rebels, finding Bawbin protected, would make a detour and head towards Kunsan. It was decided, therefore, to remain at Kunsan and await developments. On the 29th morning, Forest villagers returned with the information that the volunteer party at Bawbin were returning to Zigon, but unfortunately they failed to discover that a platoon of Burma Rifles were to relieve the volunteers. As Bawbin was a more important place to protect than Kunsan, the column moved off on the 30th and reached Bawbin at 11 a.m., finding that the Burma Rifles had already established a camp in the fields just outside the village. It was now possible to get some reliable news concerning the rebels, and it appears that, after the attack on Waing, they made for a Karen village in the hills, looted food, and shot one woman who attempted to run away. They then continued their journey east, and were reported to be making for a Karen village 18 miles north-east of Bawbin. The column remained at Bawbin on the 31st, whilst the Burma Rifles did a tour in the jungle in the hope of getting some more information. That evening a football match was played in which the Forest Department, the Burma Rifles and the Military Police took part. Arrangements were then made for a move north, with a view to carrying on the work which had been interrupted, but here a new

difficulty arose. The majority of the elephant establishment refused to accompany the party, saying that it was not safe for them to wander about in the jungle to catch their elephants all the time that the rebels were at large. As the column could not proceed north without elephant transport, it was decided to move west by road, and by borrowing two lorries belonging to the Burma Rifles, which had to do the journey four times, the column reached Kangyi. Here, during a halt of seven days, two compartments were girdled over, some 500 teak logs measured and classified, fire-lines cleared, and all current work inspected. Here also, visits were received from the Conservator, the D.F.O., Myitmaka Extraction Division, the Officer Commanding the Military Police post at Bawbin (who had relieved the Burma Rifles), and the Forest Officer attached to that post. On the 6th February, an interesting football match was played between teams representing the two garrisons (Kangyi and Bawbin). The teams were thoroughly representative, Europeans, Burmans, Karens and Indians all taking part. After a very exciting game, Bawbin won by the only goal scored. The Military Police post was withdrawn from Bawbin on the 8th February, and on that day three Officers left the column for duty elsewhere. On the 9th of February the column moved back to Bawbin to measure up some logs, and on the 12th, sufficient volunteers from the elephant staff being available, a move was made northwards. Kunsan was reached about 11 o'clock, and the rest of the day turned out to be one of the most exciting periods of the whole tour. Half an hour after reaching camp, a villager arrived with the news that a party of about 200 rebels were at a village four miles away, and that several houses in the village had already been burnt. As this village was a notorious hot bed of sedition, the story was readily believed and the camp prepared for action. Forest villagers were sent out to the edge of the jungle to report any movement, and later three Officers went out with a strong patrol, to try and get into touch with the rebels. During the afternoon, one of the Divisional mahouts arrived from Bawbin with a story that he had been captured by rebels whilst he was searching for his elephant, but had been released on stating that he was searching for his cattle.

This story more or less fitted in with the other one, and it was confidently expected that the camp would be attacked. The first informer was sent off with a Forester to give information to the nearest Township Officer, and to send wires to the Sub-divisional Officer at Zigon and to the Deputy Commissioner at Tharrawaddy. The column spent an anxious night, but nothing happened. It transpired later, that the supposed rebels were really a strong Police party carrying out a raid, and that the party which had caught and questioned the mahout, were Karen volunteers who were searching for stray rebels in the jungle. The next two days were uneventful and were devoted to forest works. On the night of 14th/15th February, hope, which for ever springs eternal in the human breast, was once again raised on high. Every one not on duty had retired to rest, when a commotion in the camp indicated the arrival of a messenger. This proved to be a Forester from Zigon with a telegram, and visions of night marches, surprise attacks, and total annihilation of the enemy etc., flashed through the minds of all those who had succeeded in waking up sufficiently. The telegram was hurriedly opened and read aloud to a group of people in various stages of undress, and the disgust and disappointment when it was found that the telegram merely ordered the return of one of the party to take charge of a Police post, can be better imagined than described. This anti-climax was too much for the younger members of the party, who went off into peals of laughter, much to the disgust of the messenger, who had travelled 18 miles since nightfall with this important (?) message. Having finished what forest work there was to do in this area, the whole column returned to Zigon on the 15th February, travelling 24 miles, six of which had to be done with elephant transport, and the remainder with lorries. The journey took seven hours, owing to various elephants not turning up until 8 o'clock, and the difficulty of obtaining a sufficient number of lorries at such short notice. So ended an interesting and somewhat disappointing tour. Nothing very much was accomplished, but the peculiar conditions under which the tour was carried out must be taken into consideration. The strength and hiding places of the rebels were unknown, and the

majority of the local inhabitants, being secretly in sympathy with the rebels, would give no reliable information. The rebels were extremely mobile, and their information regarding the movements of Government forces was very accurate. Rumours, which more often than not turned out to be false, were flying about in all directions, and it was difficult to convince subordinates and villagers that the rebels were not doing so much damage and winning so many fights as they were reported to be doing. The credulity of the average Burman is simply amazing, and he will readily believe anything, especially if it is "agin" the Government. A party of 20 rebels armed with one gun soon becomes 200 rebels and 20 guns, and an attack on a defenceless village by a few local "bad hats" in search of loot, becomes a large battle between the main rebel army and Government forces, by the time the news travels through half-a-dozen villages. However, the subordinates as a whole did extremely well and were as keen as mustard. Had the column had the good fortune to encounter the rebels, every man would have thanked his own particular God, and would then have set to work to prove that forestry was not the only accomplishment of the members of the Forest Department.

WITH THE ABORIGINES OF THE ANDAMANS.

By M. C. C. Bonington, I.F.S.

The Negritos (Little Negros) of the Andamans are survivors of an ancient race which at one time inhabited the Asiatic continent whence it was driven out by the Dravidians, Aryans and Mongolians. They are mentioned in old Hindu legends as Rakshasas, the traditional enemies of the Aryans. Anthropologists have noted traces of them inbred in other races in Assam and elsewhere, their nearest relations being the Samang or forest dwarfs of Malaya, also called Orang Utan (forest man). Indeed, judging from photographs, there seems little racial difference between them and the Andamanese. Further east, remnants of Negritos are found in the Philippines but they are, however, dying out everywhere. In the Andamans only about 450 souls now

remain compared with 6,000 estimated 3 generations ago. They are of unmixed race *vide* Dr. Hutton's article on the races of South East Asia ("Encyclopædia Brittanica"), though anthropologists, who have studied them, surmise somatic influences of Arabs, Malays and perhaps Aryans. This surmise is, however, only based on observations of facial features and requires confirmation. It is thought that Malay and Arab blood may have been introduced by surviving shipwrecked mariners, pirates and slave hunters, for instances are on record within the last century where Andamanese slaves were sold at Eastern courts.

When the present settlement of Port Blair was formed all the tribes were hostile and one of the main objects of its formation was to put an end to the frequent massacres of the shipwrecked crews of sailing vessels. With some difficulty the pioneers succeeded in befriending most of the tribes but contact with civilization had fatal effects on these primitive people. Infectious diseases took a terrible toll and these diseases, as well as a changed mode of life, further sapped their vitality so that among the friendly tribes there are to-day only half a dozen children of pure stock and a similar number of mixed Negrito Indian stock. It is, however, otherwise with the hostile and semi-hostile tribes who are still represented by some 400 individuals with a normal percentage of children.

The Jarawas, who inhabit the forests adjoining the settlement, have remained hostile and, though individuals have been captured, treated well and set free again, the tribe has remained implacably hostile and they take annual toll of villagers on the outskirts of the settlement and of labourers at forest camps. This hostile attitude has, however, preserved them from the process of decimation. A few of them have been shot in retaliation, but the wastage is probably no more than it was in pre-contact days when the Jarawas were the bitter enemies of the Aka-Bea, an adjoining but now extinct tribe.

The Jarawa is a jungle dweller nomadic by nature and only seldom comes to the coast. He lives by hunting and puts up his leaf shelter in a few minutes by merely bending down a few

saplings. He has a few communal huts in unfrequented parts of the forests where he gathers occasionally for special festivities and where he keeps his trophies of pig skulls, neatly done up in cane work and suspended over the central fire place.

The Jarawa does not require paths through the impenetrable jungle and wears no clothing to get caught by canes or thorns, he is not inconvenienced by ticks and leaches, he does not need to carry rations, for the forest furnishes a plentiful supply of roots, fruits, honey and pig which he can always gather *en route*. The larvæ of longicorn beetles can nearly always be found in some fallen tree and are a special delicacy. It is, therefore, small wonder that the Jarawa is difficult to follow after his raids, as he is careful never to attack unless sure that he will win the day. He often gets round the flank and follows at a distance those who are trying to track him down, and turns up at the most unexpected moments, and then the arrow, which seldom misses its mark, is the first indication of his presence. In spite of the inconvenience caused, may he keep aloof from contact with civilization by remaining implacable, for it is the only chance of survival of the race. The only way to deal with this primitive forest man is that of the old biblical law "An eye for an eye", that is, not to rest until he has lost a man for everyone he slays, otherwise his raids would be unbearably frequent.

While the Jarawa is a jungle dweller, the remaining friendly Andamanese are coast-dwellers. They spend a great deal of their time in shooting fish on the shallow reefs or harpooning turtle and dugong from their dug-outs. When hunting the latter the more experienced man stands in the prow, the place of honour, with a long bamboo which he uses to pole the outrigger dug-out over the shallow waters, while the man at the stern paddles and guides the boat as directed. At the end of the bamboo is a receptacle for the harpoon, a barbed iron, and this is attached to a long rope made of hibicus fibre (*Hibiscus mucronata*), which is stuck in the soft wood of the canoe. When a likely place for dugong or turtle is reached, the harpoon is fixed to the bamboo

and the line is led over the shoulder into the canoe where it is neatly coiled so as to run free and its end is fastened to the canoe.

Dugong and turtle hunting is quite an exciting sport. The, suspense of sitting silently in the boat looking for the quarry eventually locating it, the attitude of the harpooner as he bends in its direction, the few quick strokes of the paddle as the canoe-races forward and the final plunge of the harpooner when he throws himself in the water with all his weight on the shaft, the wake of the animal as it gets up speed, the running out of the rope through one's hands, the speed of the canoes when finally towed by the animal give a few exciting moments never to be forgotten.

THE USE OF "TOP HEIGHT" IN THE APPLICATION OF EXISTING YIELD TABLES.

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1. *Introductory.*—The 1929 Silvicultural Conference held at Dehra Dun discussed at length the use of dominant height in the compilation and use of yield tables, but finally decided not to alter the present procedure of differentiating quality classes on the basis of crop height and age, pending further investigation into the question by the Central Silviculturist in consultation with the Provincial Research Officers. The investigation in question is, at the moment, actually in hand, but it is probable that it will be sometime before the results will be available in their final form for practical application. In the meantime, one of the chief objections against the use of the published yield tables, namely that they are based on crop height which cannot be readily determined in the field, has to be met if these tables are to be applied to our crops. For this purpose, dominant height values, referred to here as "top heights", are required corresponding to the crop height figures given in the existing tables. These have now been worked out for sal (*Shorea robusta*) High Forest and

Coppice, deodar (*Cedrus Deodara*), blue pine (*Pinus excelsa*) and *chir* (*Pinus longifolia*) yield tables. It may be emphasised that in compilation of the top height figures no departure whatever is involved from the accepted basis of qualities, and the differences between the top and crop heights as given below have been derived from the relationship between the observed differences and the top heights, without in any way altering the crop values given in the published tables.

2. *Allotment of crops to locality quality-classes.*—Before the yield tables can be applied to any crop, allotment to its appropriate locality quality class must first be made. This is done by comparing the age and average height of the crop with the corresponding yield table values. For this purpose, the height limit values are more convenient than the mean crop heights.

To get crop height, the "top height" must be determined in the field. By "top height" is meant the average total height of dominant and such co-dominant trees as reach at least the general level of the crowns. For all practical purposes, it may be computed as a simple arithmetic average of height measurements taken on say 25-50 trees per acre according to age and size of the crop. The crop height is then obtained by subtracting from the top height the appropriate value of the difference given in the table of differences between the top and crop heights.

Crop age is determined by counting the number of rings on the stumps of dominant and co-dominant trees representative of the range of diameters in the crop, and averaging them, due allowance being added for the number of years taken to reach the stump height,

Example 1.

In the case of deodar sample plot 48, Chakrata Division, the top height and age determined by the above method were found to be 105 feet and 92 years respectively. To allot it to its quality class :—

Top height	=105′
Deduction to get crop height, read from the table of differences	=5′
Crop height	=100′
Age	=92

Yield table limits of crop height for age 92, quality II are 77′ - 104′. Therefore quality class = II.

3. *Determination of fractional quality and density of crops.*—For many practical problems of management, yield tables are required to determine the growing stock and the yield or increment of a crop, and for this purpose it is necessary to have a closer estimate of the quality, which measures quantitatively, on a *conventional scale*, the combined effect of the various factors prevailing in the locality, such as soil, climate, elevation, aspect etc. It is also necessary to have a similar quantitative measure of the density.

For the estimation of fractional quality, besides the mean curves, the limiting curves differentiating the qualities on the basis of average height and age are required. The mean curve for each quality is denoted by unity, and the range on either side of it is also taken as unity on the conventional scale, so that the total range for a given quality is 0 to 2 at any point of the age scale (x-axis). The fractional quality is then easily determined by linear interpolation.

In the case of density, which is determined on the basis of the number of trees per acre and the crop diameter, a similar method is followed. The actual density of the crop is determined from the curves giving the mean and limiting values of the number of trees per acre for different qualities, the interval between the mean and limiting curves for a given diameter being taken as unity. In interpolating for the fractional quality from these curves care should be taken, as the order of the quality curves is usually the reverse of that of the crop height and age curves.

Example 2.

Using the data of example 1.

To determine its fractional quality and density. The number of trees per acre and crop diameter are 114 and 18·8" respectively.

(*a*) *Fractional quality.*

Actual average height	=100
Actual age	=92
Yield table heights from limiting and mean curves for quality II, age 92, are	=77-90-104
Conventional scale	=0-1-2
∴ Unit interval	=104-90 =14
Interpolating for 100-90, we have 10/14	=·7
Hence fractional quality	=1·7 of II Quality.

(b) Density.

Actual number of trees per acre	= 114
Actual average diameter	= 18·8
Yield table numbers from the limiting and mean curves for crop diameter 18·8″ are	= 183-198-214 trees per acre.
Unit interval	= 198-183 = 15 trees.
Interpolating for 1·7 II quality, we have ...	= 0·7 x 15 = 11 trees.
Yield table figure for quality 1·7 II	= 198-11 = 187
∴ Density	$= \frac{114}{187} = 0·6$

The fractional quality and density of the crop are usually recorded thus: Quality 1·7 II, and 0·6 respectively.

The following example shows how the stem timber volume, increment, and volume of thinnings can be deduced for fractional quality and density from yield tables which only give values for integral qualities and unit density.

Example 3.

Given the fractional quality, crop density and age of sample plot 48, Chakrata Division, as 1·7 II, 0·6 and 92 years respectively, (see example 2 above), to determine the stem timber volume of the main crop and its increment per acre for 8 years *i.e.*, up to the age of 100 years. Also to determine the volume of thinnings.

Limiting and mean values of volumes from the yield tables for Quality II, age 92 ...	= 5,950 – 7,850 – 10,550 c. ft. per acre.
Unit interval	= 10,550 – 7,850 = 2,700 c. ft. per acre.
Interpolating for 1·7 Quality II, we have main crop volume per acre at age 92, density 0·6 ...	= 0·6 × (7,850 + 0·7 × 2,700) = 5,844 c. ft. per acre.
Limiting and mean values of volumes from the yield tables Quality II. age 100 ...	= 6,725 – 8,800 – 11,500 c. ft. per acre.
Unit interval	= 11,500 – 8,800 = 2,700 c. ft. per acre.
Interpolating for Quality 1·7 II, density 0·6, we have main crop volume per acre at age 100 ...	= 0·6 × (8,800 + 0·7 × 2,700) = 6,414 c. ft. per acre.
Therefore main crop increments for the period of 8 years ...	= 6,414 – 5,844 = 570 c. ft. per acre.

To determine the volume of thinnings for the same period, we may use the formula :—

$T = I - (V_2 - V_1)$,

When T = Volume of thinnings.

I = Total increment during the period, read from the tables and interpolated for the fractional quality and density.

V_1 = Volume of main crop at the commencement of the period.

V_2 = Volume of main crop at the end of the period. The current annual increment read from the tables and interpolated for Quality 1·7 II and density 0·6 = 0·6 (142 + 0·7 × 13) = 91 c. ft.

∴ Total increment for 8 years $= 8 \times 91 = 728$ c. ft. per acre. Substituting these values of I, V2 and V1 in the above equation, we have T (thinnings) $= 728 - 570 = 158$ c. ft. per acre. Both thinnings and increments can also be directly calculated from the values given in the tables by the same method of interpolation for fractional quality and density.

SPECIES :—*CEDRUS DEODARA.*

Table of differences between the Top and Crop heights to obtain the Crop height.

Top height.	Difference between Top and Crop height.	Top height.	Difference between Top and Crop height.	Top height.	Difference between Top and Crop height.
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
40	8	74	9	108	5
41	8	75	9	109	5
42	8	76	8	110	5
43	8	77	8	111	5
44	8	78	8	112	5
45	8	79	8	113	5
46	8	80	8	114	5
47	8	81	7	115	5
48	8	82	7	116	5
49	8	83	7	117	5
50	8	84	7	118	5
51	8	85	7	119	5
52	8	86	6	120	5
53	8	87	6	121	5
54	8	88	6	122	5
55	8	89	6	123	5
56	8	90	6	124	5
57	8	91	6	125	5
58	8	92	5	126	5
59	8	93	5	127	5
60	8	94	5	128	5
61	8	95	5	129	5
62	8	96	5	130	5
63	8	97	5	131	5
64	8	98	5	132	5
65	9	99	5	133	5
66	9	100	5	134	5
67	9	101	5	135	5
68	9	102	5	136	5
69	9	103	5	137	5
70	9	104	5	138	5
71	9	105	5	139	5
72	9	106	5	140	5
73	9	107	5		

Standard error of estimate for the above table $= \pm 0{\cdot}8'$.

SPECIES:—*PINUS EXCELSA.*

Table of differences between the Top and Crop heights to obtain the Crop height.

Top height.	Difference between Top and Crop height.	Top height.	Difference tween Top and Crop height.	Top height.	Difference between Top and Crop height.
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
30	4	71	6	111	4
31	4	72	6	112	3
32	4	73	6	113	3
33	5	74	6	114	3
34	5	75	6	115	3
35	5	76	6	116	3
36	5	77	6	117	3
37	5	78	6	118	3
38	5	79	6	119	3
39	5	80	6	120	3
40	5	81	6	121	3
41	5	82	6	122	3
42	5	83	6	123	3
43	5	84	6	124	3
44	5	85	6	125	3
45	5	86	6	126	3
46	5	87	6	127	3
47	5	88	6	128	3
48	5	89	6	129	3
49	5	90	6	130	3
50	5	91	6	131	3
51	5	92	6	132	3
52	5	93	6	133	3
53	5	94	6	134	3
54	5	95	6	135	3
55	5	96	5	136	3
56	5	97	5	137	3
57	5	98	5	138	3
58	5	99	5	139	3
59	5	100	5	140	3
60	5	101	4	141	3
61	6	102	4	142	3
62	6	103	4	143	3
63	6	104	4	144	3
64	6	105	4	145	3
65	6	106	4	146	3
66	6	107	4	147	3
67	6	108	4	148	3
68	6	109	4	149	3
69	6	110	4	150	3
70	6				

Standard error of estimate for the above table $= \pm 1{\cdot}2'$.

SPECIES :—*PINUS LONGIFOLIA.*

Table of differences between the Top and Crop heights to obtain the Crop height.

Top height.	Difference between Top and Crop height.	Top height.	Difference between Top and Crop height.	Top height.	Difference between Top and Crop height.
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
25	4	67	7	109	3
26	4	68	7	110	3
27	4	69	7	111	3
28	4	70	6	112	3
29	4	71	6	113	3
30	4	72	6	114	3
31	4	73	6	115	3
32	5	74	6	116	3
33	5	75	6	117	3
34	5	76	5	118	3
35	5	77	5	119	3
36	5	78	5	120	3
37	5	79	5	121	3
38	5	80	5	122	3
39	6	81	5	123	3
40	6	82	5	124	3
41	6	83	5	125	2
42	6	84	5	126	2
43	6	85	4	127	2
44	6	86	4	128	2
45	6	87	4	129	2
46	7	88	4	130	2
47	7	89	4	131	2
48	7	90	4	132	2
49	7	91	4	133	2
50	7	92	4	134	2
51	7	93	4	135	2
52	7	94	4	136	2
53	7	95	4	137	2
54	7	96	4	138	2
55	7	97	4	139	2
56	7	98	4	140	2
57	7	99	4	141	2
58	7	100	4	142	2
59	7	101	4	143	2
60	7	102	3	144	2
61	7	103	3	145	2
62	7	104	3	146	2
63	7	105	3	147	1
64	7	106	3	148	1
65	7	107	3	149	1
66	7	108	3	150	1

Standard error of estimate for the above table = ± 0·9′.

SPECIES:—*SHOREA ROBUSTA* (HIGH FOREST)

Table of differences between Top and Crop heights to obtain the Crop height.

Top height.	Difference between Top and Crop height.	Top height.	Difference between Top and Crop height.	Top height.	Difference between Top and Crop height.
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
30	6	64	6	98	4
31	6	65	5	99	4
32	6	66	5	100	4
33	6	67	5	101	4
34	6	68	5	102	4
35	6	69	5	103	4
36	6	70	5	104	4
37	6	71	5	105	3
38	6	72	5	106	3
39	6	73	5	107	3
40	6	74	5	108	3
41	6	75	5	109	3
42	6	76	5	110	3
43	6	77	5	111	3
44	6	78	5	112	2
45	6	79	5	113	2
46	6	80	5	114	2
47	6	81	5	115	2
48	6	82	5	116	2
49	6	83	5	117	2
50	6	84	5	118	2
51	6	85	5	119	2
52	6	86	5	120	2
53	6	87	5	121	2
54	6	88	5	122	2
55	6	89	5	123	2
56	6	90	5	124	2
57	6	91	5	125	1
58	6	92	5	126	1
59	6	93	5	127	1
60	6	94	4	128	1
61	6	95	4	129	1
62	6	96	4	130	1
63	6	97	4		

Standard error of estimate for the above table $= \pm 0{\cdot}9'$.

SPECIES :—*SHOREA ROBUSTA* (COPPICE)

Table of differences between the Top and Crop heights to obtain the Crop height.

Top height.	Difference between Top and Crop height.	Top height.	Difference between Top and Crop height.	Top height.	Difference between Top and Crop height.
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
20	3	45	7	70	6
21	3	46	7	71	6
22	4	47	7	72	6
23	4	48	7	73	6
24	4	49	7	74	6
25	5	50	7	75	6
26	5	51	7	76	5
27	5	52	7	77	5
28	5	53	7	78	5
29	6	54	7	79	5
30	6	55	7	80	5
31	6	56	7	81	5
32	6	57	7	82	5
33	6	58	7	83	5
34	6	59	7	84	5
35	7	60	6	85	5
36	7	61	6	86	5
37	7	62	6	87	5
38	7	63	6	88	5
39	7	64	6	89	5
40	7	65	6	90	4
41	7	66	6	91	4
42	7	67	6	92	4
43	7	68	6	93	4
44	7	69	6	94	4
				95	4

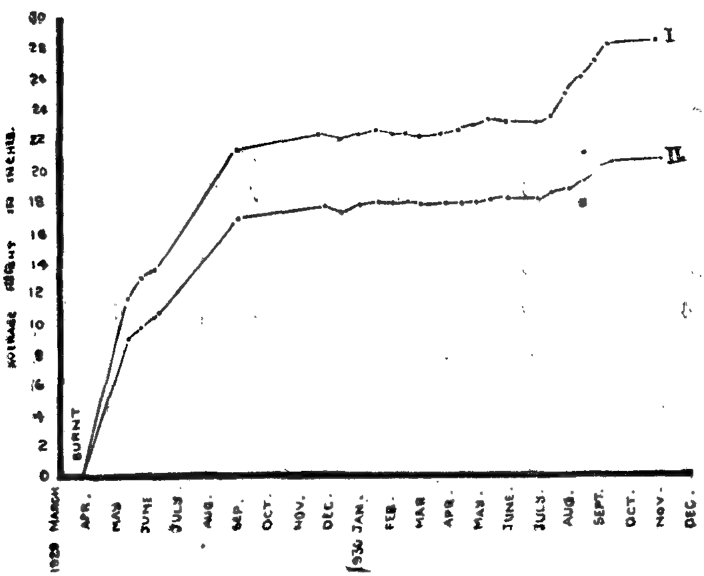
Standard error of estimate for the above table $= \pm 1 \cdot 2'$.

SEASONAL GROWTH OF SAL SEEDLINGS.

M. D. CHATURVEDI, I.F.S.,
Silviculturist, U.P.

Fortnightly observations on the rate of growth of sal seedlings included in indicator plots* laid out in the 1st quality *bhabar* areas at Lakhmanmandi† (Haldwani) reveal some interesting facts. The indicator plots were fenced with wove wire followed by 5 strands of barbed wire so as to exclude game; for a seedling once browsed is rendered useless for seasonal growth studies. One indicator plot was fenced twice to make it absolutely game proof. The rainfall was normal.

2. The average ‡ height of a *constant* number of seedlings plotted against the date of observation gives the following curves :—



*A plot 60 ft. by 80 ft. (with a diagonal of 100 ft.) is the standard size of the indicator plot adopted by the writer. About a 100 typical seedlings are kept under observation, and the position of each seedlings is marked on the ground with a number nail, and graphed on paper. The plot is divided into 4 parts each of which includes 25 seedlings to ensure the distribution of seedlings all over the area.

†Soil, rich loam of considerable depth probably overlying river gravels Elevation 1,000 ft. approximately. Annual rainfall, 75 inches.

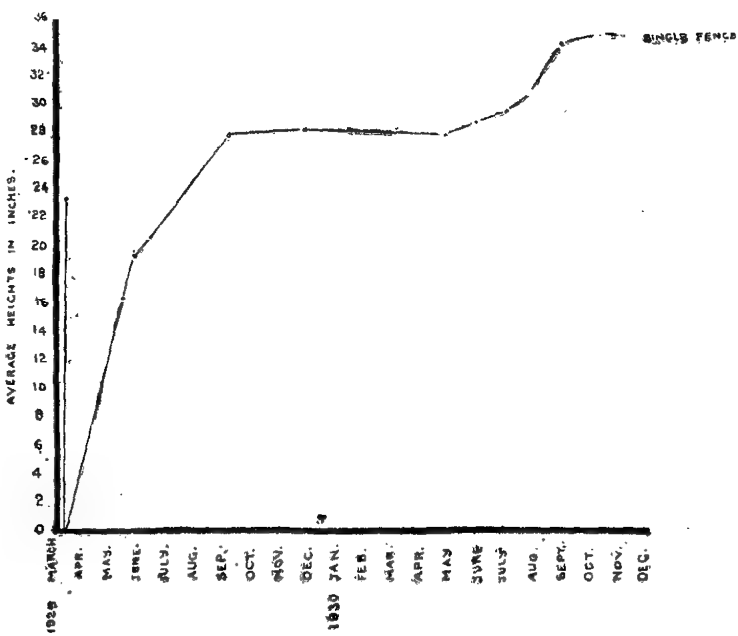
‡The arithmetic mean.

Curve I.—82 seedlings growing under a light overwood of 18 trees of mean diameter at breast height 19·8 inches per acre. (Indicator Plot No. 1).

Curve II.—83 seedlings growing under a dense overwood of 69 trees of mean diameter at breast height 15·6 inches per acre. (Indicator Plot No. 2).

These plots were burnt on March 26, 1929.

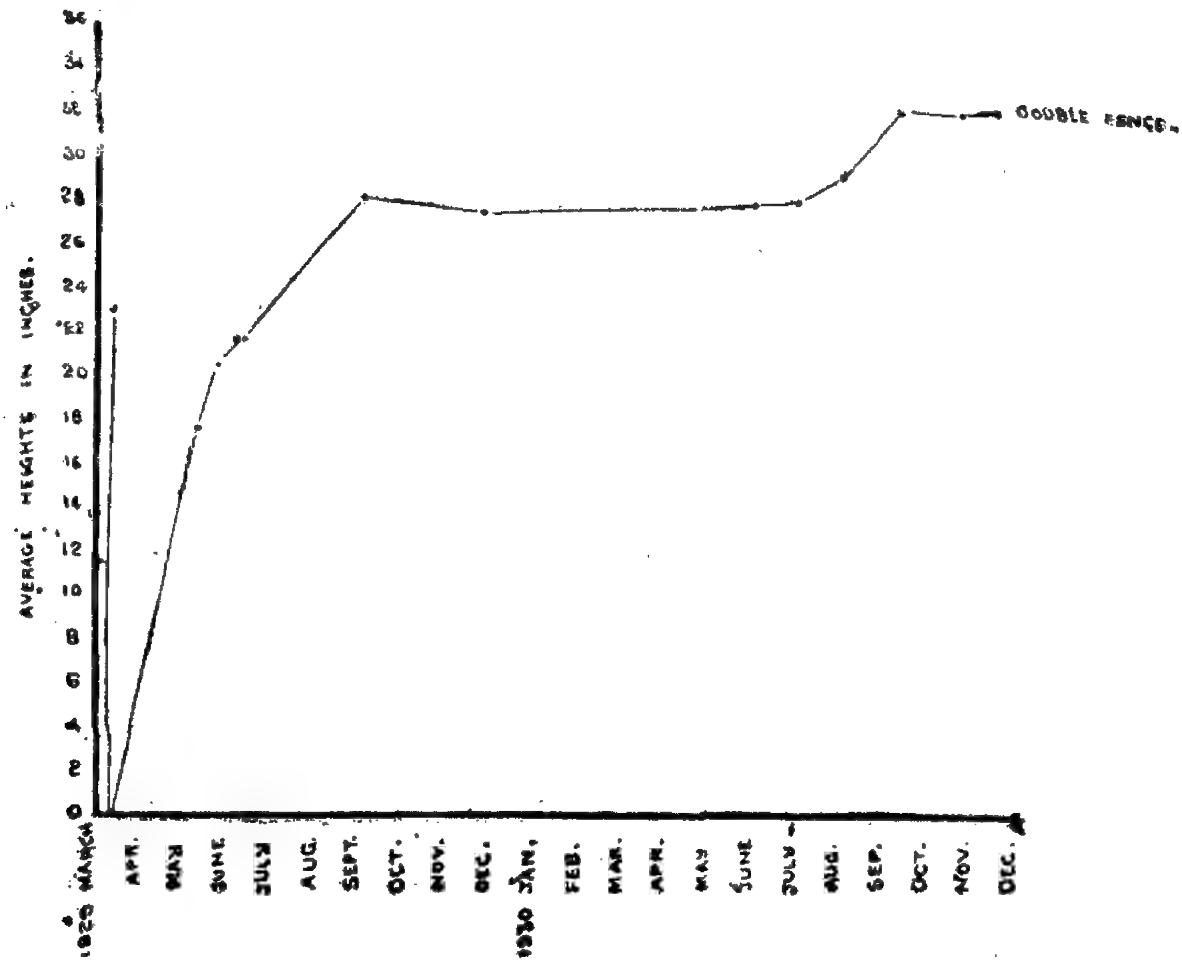
3. Another curve obtained for an indicator plot (No. 3) in an adjoining area is also given below :—



94 seedlings growing under an overwood of 36 trees of 7·2 inches mean diameter at breast height per acre. The plot was burnt on March 13, 1929.

4. An indicator plot (No. 4) laid out side by side with the above was fenced twice so as to make it absolutely game proof. The average height of 100 seedlings growing under an overwood of 36 trees of 14·6 inches mean diameter at breast height per acre

plotted against the date of observation gave the following curve The plot was burnt on March 13, 1929.



5. Measurements of seedlings in the indicator plots mentioned above are given below :—

Table I.

	Indicator Plots.			Indicator Plots.	
	No. 1.	No. 2.		No. 3.	No. 4.
No. of seedlings.	82	83	No. of seedlings	94	100
Date of observation.	Average height in inches.	Average height in inches.	Date of observation.	Average height in inches.	Average height in inches.
1929.			1929.		
March 26 ..	The area was burnt very severely by accident.		March 12 ...	23·4	22·7
May 10 ..	11·8	9·1	March 13 ...	The area was burnt and the fire was light	
May 24 ...	13·3	10·0	May 12 ...	16·5	17·7
June 9 ...	13·7	10·8	May 25 ..	19·3	20·6
September 4 ...	21·4	16·9	June 9 ...	20·5	21·7
November 26 ...	22·1	17·4	September 4	28·1	28·2
December 16 ...	21·8	17·1	November 27	28·2	27·7
1930.			1930.		
January 5 ...	22·0	17·5	April 29 ...	27·8	28·1
January 22 ...	22·3	17·6	June 1 .	28·6	28·6
February 7 ...	22·0	17·5	July 1 ...	29·0	28·9
February 22 ...	22·0	17·5	August 1 ...	30·4	30·2
March 3 ...	21·8	17·3	September 3	34·0	33·5
March 27 ...	21·9	17·4	October 16 ...	34·6	33·6
April 14 ...	22·1	17·3	November 7	34·4	33·9
April 29 ...	22·3	17·4			
May 15 ...	22·6	17·4			
June 1 ...	22·4	17·5			
July 1 ...	22·3	17·3			
July 15 ...	22·8	17·8			
August 1 ...	24·2	17·8			
August 17 ...	25·2	18·4			
September 2 ...	26·2	19·4			
September 16 ...	27·3	19·7			
November 5 ...	27·5	19·7			

CONCLUSIONS.

6. (*a*) Under average forest conditions*, with game excluded, the new shoots which the unestablished sal seedlings send out after a fire in March grow rapidly and practically attain their original height before the monsoon sets in June.

(*b*) The growth is continued till about the end of September. From October till the following June the growth is practically negligible. For all intents and purposes there is no growth during the following March, April and May. The growth starts once more at the break of second monsoon and lasts again till the end of September.

(*c*) The second growing season of the sal seedlings practically coincides with the rainy season, and the month of August is characterised with the maximum height development.

(*d*) *Ceteris paribus*, the development of seedlings under a light overwood (18 trees to an acre) is much better than under dense overwood (69 trees to an acre) *Vide* curves I and II in para 2.

7. In his note on 'The development of sal seedlings in Gorakhpur *taungya*' Mr. Shaukat Hussain (1) has described the almost continuous growth of sal seedlings right through the cold weather—a phenomenon which he has sought to explain by the fact of the seedlings growing under the west Lehra *taungya* conditions which imply, good well worked soil, efficient weeding, effective drainage, plenty of overhead light, and a mild winter with little or no frost. And even under these conditions the growth during the cold weather is a slow affair. Actual figures of measurements of heights of seedlings are unfortunately not recorded by him to enable one to compare the growth of seedlings month by month.

8. The record of height measurements of 10 seedlings raised from seed in a *nursery* bed at the Experimental Silvicultural garden, Dehra Dun, carried out by Messrs. H. Trotter (2) and

* Conditions which obtain in 1st quality *bhabar* sal areas, with rich deep loamy well drained soils. Elevation, 1,000 ft. Average rainfall, 75 inches.

S. H. Howard (3) may also be briefly referred to here. Mr. Howard records* that sal seedlings commence their height growth in the second growing season in April, grow more in May, and continue steadily till the end of September, with a maximum in June. They commence their third growing season in March, grow well in April and very rapidly in May and June. In July they do little, but start again in August and grow a lot in September. They follow the same trend in their fourth growing season except that a slight decrease is noticed in August.

9. My own measurements of the heights of 359 seedlings growing under forest conditions in a first quality *bhabar* sal area, with game excluded, do not indicate any material growth during March, April and May.

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1. Shaukat Hussain, M. ... The Development of Sal Seedlings in Gorakhpur *Taungya*.
Ind. For. February 1925, P. 69, *et seq.*

2. Trotter, H. ... Height Growth of Seedlings.
Ind. For. December 1922, P. 640, *et seq.*

3. Howard, S. H. ... Height Growth of Seedlings.
Ind. For. January 1924, P. 11, *et seq.*

........,,.......... Height Growth of Seedlings.
Ind. For. February 1925, P. 72, *et seq.*

FOOTNOTE.

*Growing season.	HEIGHT INCREMENT.								
	March.	April.	May.	June.	July.	August.	September.	October.	November-February.
Second ...	...	·3	·8	3·8	2·3	1·1	1·2	·3	·1
Third ...	2·5	2·0	6·6	8·3	0·5	2·2	0·7	...	...

NOTE ON A CASUARINA PLANTATION AT PURI (ORISSA).

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Forest Research Officer, Bihar and Orissa.

Object of the Plantation :—

(*a*) To supply fuel to the town of Puri. At present the price of fuel is very high and there are no forests in the neighbourhood of Puri from which supplies of fuel are obtainable, most of the fuel coming by rail from forests round Khurda and Cuttack.

(*b*) To fix the sand dunes.

(*c*) Incidentally, to help to improve the agricultural land behind the plantation by affording protection against the sand which is blown inland.

(*d*) To add beauty to the foreshore and to enhance the value of Puri as a sea-side resort.

Area and Situation :—

The plantation is 3,555 acres in extent and is situated about 2 miles east of Puri town, on the east coast of the Bay of Bengal.

This area originally consisted of waste sand dunes on which there was practically no vegetation of any kind. As a preliminary to the planting of *Casuarina* it was decided to form a hedge at once of *Opuntia* (cactus) and *Pandanus* (*keora*), on the windward side to plant *talipot* (*Borassus flabelliformis*) at intervals to mark the boundary and also to introduce as wind breaks *poonang* (*Calophyllum Inophyllum*) and cashew-nut (*Anacardium occidentale*) and to bind the sand with *Ipomaea biloba*, the goat-foot creeper.

Poonang (*Calophyllum Inophyllum*) :—

Poonang thrives on sandy soil or in pure sand in the town of Puri and is found associated with cocoanut, *Casuarina* and *Anacardium occidentale*. It is a middle-sized tree with low

spreading crown, very ornamental and produces small white highly scented flowers. The tree becomes mature and begins to yield fruit after about 10 years and is said to fruit three times a year, but only the rains and winter crop are collected. The fruit is not edible but yields *poonang* oil which is used extensively in Orissa for burning, the residue after expression of the oil being used as a manure. The oil is also exported to Calcutta where it is said to be used for the manufacture of soap. Each tree yields about 2 maunds of seed and is worth about Rs. 2 so the introduction of this tree appeared justifiable on account of its economic importance alone. As it is, however, a slow growing tree, the planting of *Casuarina* could not be delayed until the *poonang* had grown sufficiently to serve as an effective wind-screen, so it never served the actual purpose for which it was introduced. Cactus has grown very well and forms a very good hedge, while *Borassus* trees are few and far between. There are some cashew-nut trees, which have remained small and have not proved suitable as a wind-screen.

Casuarina :—

Casuarina equisetifolia is not indigenous to India having probably been introduced from Persia through Australia. It bears considerable resemblance to the conifers, and the needles fall throughout the year. One or two main roads are lined with *Casuarina* trees in Puri and it is a common sight to see the poor people collecting the fallen needles which they use as fuel. They are not, however, allowed to collect needles from our plantation areas, as it is likely that the soil is being improved by the addition of organic matter. On the other hand, they have found in Bombay that the growth of the *Casuarina* was rather better in localities where the villagers were allowed to remove the fallen needles. This result was imputed to the fact that thick accumulations of needles tended to render the soil acid and the acidity induced was deleterious to the growth of the *Casuarina*. Another reason for the inferior growth of trees in Bombay, where the needles are not removed, is attributed to the fact that the thick layer of accumulated needles is saturated during the rains thereby

inducing the growth of fungi which retard the growth of the trees. Fungi are quite common in Puri plantation but we do not know whether they are due to the fallen leaves, nor do we know whether accumulation of the latter has induced acidity in the soil. The question whether the needles should be removed or not may prove an important question in our plantation and it is proposed to investigate this matter immediately.

Planting plan :—

In order to ensure the success of the plantation it was necessary to draw up a regular plan with reference to the direction of the wind and to provide suitable hedges which would serve as wind-screens. The figures for the wind direction were supplied by the Director-General of Observatories with the following results :—

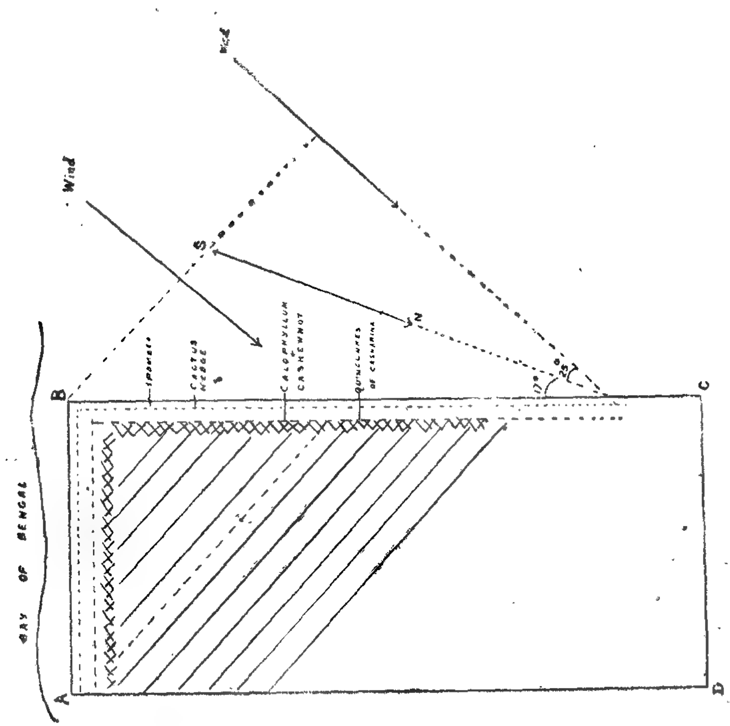
(*a*) There is scarcely ever an easterly wind. Only in November, 1913, did the wind bear 2 degrees east of north, so that it was north for practical purposes.

(*b*) From February to August, *i.e.*, 7 months of the year, the wind nearly always blows south and west, the actual average being S 54° (*i.e.*, 9° more west than south), but in February and July especially it occasionally veers to the north.

(*c*) From September to January (*i.e.*, for 5 months) the wind nearly always has elements of north and west, the actual average deduced from the monthly figures being N 24°W.

As the velocity is greatest in the hot weather especial attention had to be paid to the February to August figures. Moreover, driving sand is more likely to be harmful in the hot weather months and northerly breezes blow from the land so that all the data tended to show that the wind-screen should be more or less west of south, or west and south, and the planting should proceed east of north,

The following sketch will show the direction of the wind and the plan of planting;—



At the start, a littoral dune and hedge along AB and BC was taken in hand and cactus was planted along the dotted line and outside that along AB, BC, to a width of 10ft., *Ipomaea biloba*. On the leeward of the dotted line, cashew-nut was sown 10ft. apart. *Calophyllum* grown in the nursery was transplanted along ABC in the intervals between the cashew-nut, so that inside the dotted line there is a line of *Calophyllum* and cashew-nut 5 ft. from the cactus hedge. *Casuarina* was planted in quincunx. Most of the above work was done in 1917 with the exception of the planting of *Casuarina* which took another year to complete. The real wind-screen consisted of cactus hedge, which has grown splendidly, and of densely grown *Casuarina*; *calophyllum* being a slow growing tree did not serve this purpose. From the very start great importance has been attached to the

establishment of a wind-screen as rapidly as possible, as experience had shown that when *Casuarina* is planted along the sea-shore in Puri the wind from the sea blows them nearly flat to the ground.

The subsequent regular planting of *Casuarina* has been done in transverse lines as indicated in the above diagram.

Seed Collection:—

It is said that in Puri *Casuarina* seeds three times a year and the fruit is said to be ripe at the following seasons:—

i. March and April.
ii. July and August.
iii. October and November.

I am not quite certain if such is the case. It is possible that the second season is prolonged and this gives the impression that there are three fruiting seasons. This tree appears to flower twice in the year in Bombay—in March-April and September-October. The fruit from the 1st flowering, which is not so prolific as the 2nd, ripens in June and from the 2nd about December. We collect seeds in Puri only once a year, in October November, as it has been found that the seeds collected at this time of the year have the best germinating power.

Sowing and Planting:—

At first the seed was invariably sown in flat earthen-pots with a diameter of 12in. to 15in., each pot yielding, if carefully and evenly sown, 200 to 300 seedlings. The object in sowing in pots was that, in the event of heavy rain or strong sun, the pots could easily be moved into the sheds provided for this purpose, while if the seedlings required sun the pots could easily be put out for a few hours. Sowings in nursery beds in the ground might, it was considered, require to be protected against sun or rain. In order to afford protection to the pots, which were kept in the shed and only put out now and again when it was considered necessary, a stone wall was actually built on the wind-ward side, but this procedure has now been abandoned and the seeds are sown broad-cast in the seed beds. The seeds are also sometimes sown in pans but, as the latter are expensive and only contain a few seedlings,

they have been practically given up. No stone walls are built to protect the nursery as they are not considered necessary.

Preparation of Seed beds:—

Manured earth is mixed with sand in a proportion of one to one, the silt left in the village lands where water accumulates during the rains having been found to be a good substitute for manure. The seed beds are hoed and mixed with the above earth to a depth of about 6in. and seeds are sown over the beds and then a thin layer of sand is spread over them to prevent them from being blown away.

The seeds are sown in January and February and left in the seed beds about a month or so till they grow to about 4in. high, the seed actually germinating in about 10 days. Meanwhile pot-tiles are got ready, filled with sand and manured earth, as in the case of nursery beds. The seedlings are then transferred to these pot-tiles, which are sunk completely in the ground in slightly raised beds and are not sheltered at all. The seedlings are then left till June when they are required for planting in the field.

The seedlings are watered every day when they are in the seed beds or in the pot-tiles and are about 15in. to 18in. high when transplanted in the field. The plant holes are dug with country "*kurries*" to a depth of about 18in. The seedlings are then carefully removed from the pot-tiles with balls of earth and placed in these holes and the pot-tiles are thus recovered and used again. It appears that in Madras seed is also sown in nurseries, but the seedlings are not potted as we do in Puri and the plants are dug up and planted out direct. The tiles have the advantage of preventing the roots of adjoining plants from becoming entangled and of preventing subsequent damage to the roots of the *Casuarina* when they are being separated. Formerly, the whole pot was placed in the plant holes after its bottom had been broken off or a small hole had been made in it. This procedure was considered to be necessary on account of the violent wind which would otherwise lay the plants flat to the ground and continue to lash them to and fro about their collars. The side of the pot was thought to give support to the collar, and the pots were also sunk deep and the sand heaped several inches above

the collar. *Casuarina* did not appear to object to this treatment and seems to have special ability to withstand being rather deeply buried. The method of planting with pots, however, was abandoned after 1920, as an examination of several plants, which had died subsequent to the establishment of the plantation, showed that the roots had been cramped and they had not been able to make sufficient headway to enable the plant to establish itself. In several cases the tap root had grown into a spiral coil and had been unable to get down at all as the small hole at the bottom of the pot was not sufficiently large. The time of transplanting depends upon the locality. On ordinary level ground transplanting is done in July and August when the water level comes to within about 18 in.-24 in. of ground level but water-logged areas are planted up in November and December when the water level recedes to about 2 ft. below ground level. It is necessary to follow this procedure, as experience has shown that, if planting is done in water-logged areas in July and August, the transplants die for want of aeration. In the greater part of the planting area the transplants are watered once a week, about 1 gallon of water being given to one plant. Watering is usually carried out from January to the beginning of June and it is necessary to water the plants on coarse sand and on the dunes twice a week. Formerly watering was done only for one season after planting, but for two years past watering has been done for two seasons and this is believed to keep the plants more healthy in the initial stages. Small wells about *6 ft.-8 ft.* deep are dug at suitable intervals (2-3 wells to the acre) and the coolies draw water from them with which to water the plants.

One or two words explaining how the work is conducted may perhaps be of interest.

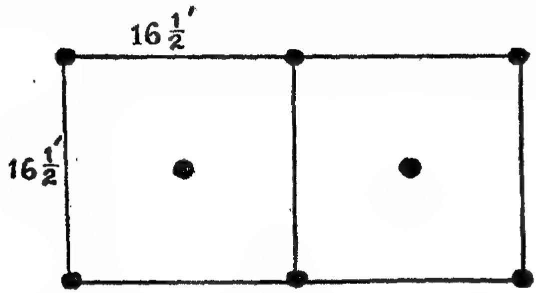
The coolies are detailed as follows :—

	4 for digging pits in advance.
	2 for carrying plants to pits.
	12 for carrying plants from the nursery.
	12 for planting.
	2 for digging up plants in nursery.
Total	32 coolies.

The cost of planting amounts to 4 annas per 100 plants if nurseries are established at suitable places. With only one nursery the cost of transport may be high and the cost of planting may consequently rise to as much as 8 annas per 100 plants. In order to avoid the necessity for carrying plants long distances the person in charge of the work is responsible for the selection of suitable sites at which to establish nurseries.

Spacing of Planting:—

The planting distance has varied from time to time and at one time it was suggested that planting should be carried out at a spacing of $16\frac{1}{2}' \times 16\frac{1}{2}'$. This was actually done over 305 acres in 1920 but it was realised that such wide spacing was a mistake as experience had shown in Madras, and this defect was subsequently remedied by putting in an extra row on the diagonal, thus :—



This gave a spacing on the average of 11′ in the area planted in 1920. The other spacings adopted have been $10' \times 10'$, $10' \times 8'$, $9' \times 9'$ and $8' \times 8'$. In some parts of Madras the spacing, I believe, is $7' \times 7'$ but I do not know the reasons for adopting the spacing. We do not yet know what spacing will give the best results, though we know that *Casuarina* develops best if given considerable space, but it appears that $10' \times 10'$ in the initial stages is much too wide. In some places where *Casuarina* plantations have been established, a wide spacing of $10' \times 10'$ has been adopted because the price of land is low and the planting costs high, but in Puri planting costs are low, while the price of land is high. Although the conditions are not quite analogous, we have nevertheless followed the spacing adopted elsewhere inspite of the fact that a $10' \times 10'$ spacing appears to have been adopted elsewhere without any

data. If thinnings are to be carried out then closer spacing should certainly be adopted as they will undoubtedly pay. We have not yet decided the lines on which this plantation will be worked, but it appears to me that no spacing wider than 8′ × 8′ is at present indicated.

Costs:—

Costs have fluctuated considerably, and have steadily gone down with experience. From 1916-17 to 1918-19 the cost of all operations (excluding the cost of land, buildings, etc.,) was Rs. 30 per acre, but this has now been reduced to between Rs. 13 and Rs. 15 per acre, including watering for two seasons, which alone accounts for about Rs. 6 per acre.

Area planted:—

The area planted has varied considerably from year to year. While only 10 and 75 acres were planted in 1916-17 and 1918-19 respectively, about 700 acres were planted in 1920-21. Since then steady progress has been made and on an average about 260 acres have been planted every year. During 1925-26, however, no area was planted at all, as proceedings under the Land Acquisition Act, under which the land has to be acquired, did not finish in time to give us possession of the land before the planting season arrived. The cost of the land has varied between Rs. 20 to Rs. 25 per acre.

Condition of the plantation:—

The plantation may be divided into two parts as regards growth and general conditions.

(*a*) North of the depression which runs right through the plantation—approximately 2,600 acres, away from the sea.

(*b*) South of this depression—955 acres, towards the sea.

Northern portion:—

(*a*) This is the best part of the plantation in which the growth is good and density uniform. Some idea of the growth and volume per acre can be gathered from the measurements taken in two sample plots of good and moderate quality respectively which are appended below:—

Age of crop.	Number of trees per acre after thinning.		Average height of crop in feet.		Average diameter of crop in inches and decimeters.		Basal area per acre after thinning sq. feet.		Volume per acre of main crop, in cubic feet.	
	Good quality.	Moderate quality.	Good quality.	Moderate quality.	Good quality.	Moderate quality.	Good quality.	Moderate quality.	Good quality.	Moderate quality.
8	208	197	51	37	4·6	3·4	24·04	12·34	480	171
31	185	170	65	61	7·4	6·5	55·23	38·89	1329	873

Note—To the volume of Main crop must be added the intermediate yield from thinnings. The yield from thinnings in the good quality sample plot is 552 cubic feet while in the moderate quality sample plot it is 279 cubic feet.

Total volume per acre in good quality area.........1,881 cubic feet at the age of 13 years.

Do. moderate do. 1,152 cubic feet do. do.

Periodic mean annual basal area increment moderate quality 4·9) sq. feet.

Do. basal area good quality 6·31 sq. feet.

The outturn of some 1,800 cubic feet per acre is lower than is obtained elsewhere and this may be due to climatic or other conditions. It may be noted here that there is a belief that the increment of the trees in Puri *Casuarina* plantation has been retarded owing to their having been pruned when they were four years old, but I am unable to say how far this belief is justified. Pruning has now been abandoned. The general condition of the plantation is quite good, except that *Arbela tetranis* is very abundant over the greater part of the area on trees of 4 in. diameter and over. Its larvæ work up to 30 ft. or more where the bark is thin and are apparently responsible for the very cankered and crooked appearance of some of the trees they have attacked. Though they have attacked a very large number of trees none of them have died, thereby showing that their attack is not fatal.

Southern portion :—

(*b*) This is very different to the northern portion. It is exposed to the sea winds and the wind-screen, consisting of *Casuarina*, falls into this area. The area is not flat as is the Northern portion, but consists of sand dunes and part contains much coarse sand. The growth is inferior as is to be expected and there have been very heavy casualties in this area. These casualties are mostly concentrated along a strip of high ground which runs right through the plantation and along a depression in which water stands in the rains.

Various causes have been assigned to these casualties :—

1. Insects :—They are not however responsible for the death of the trees in this portion of the plantation. As a matter of fact the bark eating larvæ of *Arbela tetranis* are more prevalent in the Northern portion where they have not proved fatal but have made the trees appear cankerous and sometimes crooked. Its habits may briefly be described—

The larvæ are extremely voracious and their presence is at once detected by the characteristic winding galleries on the bark of the stem and branches. They generally commence their attack at the point where the branches join the stem, the galleries

being of the covered-way type, the covering material consisting of the excrementitious matter thrown out by the larvæ.

This insect commenced an attack on a large scale about 4-5 years ago when the *Casuarina* trees were pruned in the Puri plantation, the larvæ on hatching boring a small hole in the axils of the branches which had been pruned off.

No young plant, however, seems to have been attacked by this insect, and it is also noticed that the trees which are nearest to the seashore are practically free from its attack. Though the attack is on a large scale hardly any tree seems to have been killed and, as the plantation is meant to supply only firewood and the quality of timber produced immaterial, it has not been considered necessary to destroy these insects, in spite of the fact that collection by hand is quite easy. If, however, the increment is adversely affected it would perhaps in that case be advisable to take remedial measures against this insect.

There is another insect which is found on young transplants but it has nothing to do with the death of saplings and poles which have died wholesale in this area. This insect which has been identified as *Lacanium longulum*—(one of the *Coccidæ*) sucks the sap from the cambial layer and so causes death. The remedial measure adopted is to spray all attacked plants with a weak solution of copper sulphate.

2. *Drought:—*

Casualties were first noticed in 1922 when it was reported that the whole plantation was suffering from a long continued drought and that an unusal number of failures had occurred which were particularly confined to the elevated strip about 350 yards wide running through the plantation and along the stream. It was further reported that several dead plants had been dug up and it was then found that they had not sent down any tap root and that there were only superficial side roots which were quite insufficient to supply the plants with moisture in the dry season. It was further reported that the water level in the plantation had fallen considerably and that water holes had to be dug out daily. At this time a large number of poles of

25′-30′ in height died and again in the hot weather of 1927. Drought is, perhaps, one of the causes of death but it cannot account for the casualties which have taken place in groups throughout the area, practically under all conditions and we must, therefore, look for other causes for the deaths in the latter places.

3. *Sudden fluctuation of water level:—*

It has been suggested that the mortality may be due to sudden fluctuation in water level. In order to prove or disprove this theory holes have been dug in typical areas in which the plants have failed and typical successful areas of the same age and the fluctuation in soil water level is noted every week. This experiment was, however, commenced only about three months ago.

4. *Fungi:—*

It has been suggested that some trees have been killed by fungi but this does not appear to be the case. Nearly all the dead trees carry *Polyporid* fructifications but green and healthy trees do not appear to be attacked. Fungus attack seems secondary and is therefore not responsible for killing healthy trees. The evidence points to the fact that drought, combined with sudden fluctuations in water level and the presence of coarse sand and perhaps salinity in the water, all contribute towards killing off so many trees.

Management:—

Such heavy casualties and unequal growth in the area as above described, tend to complicate the management and it is not possible to work both the portions on the same lines. As it is doubtful whether *Casuarina*, if planted in the failed area, will grow satisfactorily, various other species such as *Melaleuca Leucadendron*, *Pinus longifolia*, *Pinus caribœa*, *Grevillea robusta*, *Eugenia Jambolana*, *Careya arborea* and *Azadirachta indica*, are being tried. This is a perfectly sound policy and should be continued.

In the absence of local data the question of fixing the rotation is somewhat difficult. Elsewhere the rotation is short, (some 15-16 years), but we do not know in this case what the financial rotation or the rotation of greatest volume is likely to be. The

financial rotation will probably prove to be the culmination of the mean annual increment, as the primary value of the *Casuarina* trees is for fuel. If we start fellings now or after a couple of years—as it is proposed to do—the results obtained from the sample plots cannot be applied to the working of the present crop, as there is not many years difference between the youngest and oldest age classes. The rotation will, therefore, have to be decided before the annual increment in the sample plots has culminated. Subsequently, the data obtained from the sample plots will be of value to determine whether the arbitrarily selected rotation should be lengthened or not.

Proposals for future working:—

It has been proposed to divide the plantation into two portions so that one of approximately 1,000 acres to the south will contain the area in which the trees are at present in any unhealthy condition and are dying off. All the dead, sickly or defective poles will be felled in this area within two years.

The other area will be about 2,400 acres, after deduction of the ground occupied by houses and rides. It is proposed to work this in 16 years by clear felling and replanting. (Experiments have shown that *Casuarina* will neither coppice nor pollard satisfactorily.) The average coupe comes to 150 acres, but, owing to an uneven distribution of age classes, the earlier coupes will be smaller and will increase as time goes on, but this can be adjusted at the end of the first rotation. It is, therefore, proposed that a coupe of 100 acres be felled first. It has been estimated that the plantation will yield standing between Rs. 150 to Rs. 200 per acre.

TAUNGYA IN THE GORAKHPUR FOREST DIVISION.

By Mathura Prasad Bhola, I.F.S., and Md. Shaukat Hussain, Forest Ranger.

Bulletin No. 4 of the United Provinces Forest Department, (Research Branch).

A perusal of this interesting Bulletin shows that *taungya* in Gorakhpur Division has proved an undoubted success and appears to have solved the problem of the artificial regeneration of sal (*Shorea robusta*) at a very low cost.

Experiments in this connection were started in 1923 and these original experiments were so successful that they were continued in 1924 and 1925, with the result that the current Working Plan (Wood and Bhola 1924-25 to 1933-34) prescribed the artificial regeneration of sal wherever natural regeneration failed over large areas.

The bulletin gives an account of the method of *taungya* now adopted, supplemented by photographs, while figures given show that, with an income of Rs. 3 per acre and an expenditure of Re. 1-8-0, the net profit from *taungya* lands at the end of four years when the sal crop is completely established is Re. 1-8-0.

The advantages which the system has entailed are contained in a paragraph at the end and may be quoted. The Department regenerates its crop free of cost while the villagers raise good crops on virgin soil and thereby increase their prosperity and standard of living. The sympathy for the Forest Department engendered among the *rayats* has helped the local administration and the presence of *taungya* has provided a labour supply available at all times. Not only has *taungva* made the regeneration of sal easy, but it has undoubtedly improved its quality and has solved the problem of perpetuating this most valuable tree species in Gorakhpur.

THE WILD FLOWERS OF KASHMIR.

By B. O. Coventry.

The third series of 50 coloured plates of Kashmir flowers has appeared and differs little from the previous parts except that

many of the flowers have been photographed against a black background. This is a great improvement especially in the case of plants with white flowers, as a comparison of the figure of the Leafy Sandwort with either the Vine-leaved Anemone or Jacquemont's Pink will show. As Jacquemont's Pink is not given in the Index we might add that it is figured in plate 19. For the same reason we should mention that the Leafy Sandwort is figured in plate 20.

The addition of English names for flowers (which not being English flowers have no English names) first appeared in the second series, doubtless in response to a popular demand. The result is not very pleasing. The Denuded Larkspur and Spurious Iris (the latter mentioned in the Index !) for *Delphinium denudatum* and *Iris spuria* would have got us into trouble in the lower fourth. At any rate when we translated our Cæsar on these lines it was never well received. No English name has been given for *Corydalis ramosa.* We have looked up two Encyclopedias and one Dictionary of Gardening, works which delight in English names for everything but all fail with Corydalis. One however has proved most useful as it says Corydalis is allied to the Dutchman's Breeches—this is quite sufficient. The English name of *Corydalis ramosa* is the "Branched False Dutchman's Breeches." It is quite as euphonious as the Hooked-spurred Larkspur, the Various-leaved Monkshood, Royle's Leopard's-bane or the Tall Himalayan Hound's-tounge. We hope that this name will be recognized and included in the second edition of this book if the demand for English names warrants their retention.

VOLUME LVII.] [NUMBER 7.

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REGENERATING THE SHILLONG PINE FORESTS.

BY A. J. W. MILROY, I.F.S.

It was decided in 1920, when a new Working Plan had to be compiled for these even-aged forests, that it was time to start regenerating those compartments most ripe for the axe. Previous experiments had shown that merely opening up the canopy very often led to nothing more than an invasion by ever-green shrubs, but the great demand for land for the cultivation of potatoes offering an opportunity of regenerating the chosen compartments in conjunction with the raising of field crops a system of Vista-fellings was introduced, which would effect this without destroying the scenic amenities of the locality.

The Vistas, which varied from 200′ to 300′ in width, were sold for 3 years' cultivation, 2 with potatoes and the last year with Indian corn, and fetched as much as Rs. 18 to 20 per acre for the 3-year-period.

Potatoes are grown in the Khasia Hills in raised beds, on which brushwood is laid and ignited after first being covered with clods of earth. This practice has created a demand for the upper parts of the crowns of felled trees and for undergrowth from the forest, as the Khasias find that this burning is an essential preliminary to the raising of a good potato crop.

The idea was that the Vistas would be sown up by seed from the adjacent forest, but only very partial success was obtained,

and no improvements followed the reduction of the Vistas' width.

The surrounding Khasias are careful in many places to conserve the fertility of the soil by raising new forests of pine after their *jhums* have been abandoned, and an enquiry into their uniform success elicited the facts that the most vigorous seedlings are only obtained from seed from quite small trees, and that it is the local custom to cut cone-bearing branches from young pines and stick them in the ground every few yards apart after the final crop has been reaped.

This method will now be introduced into the Government forests, and it is to be hoped that the already opened Vistas having become fully stocked it will be possible to start fresh ones and get on with the good work.

PINTAR—AN ATTEMPT TO UTILISE PINUS LONGIFOLIA TAR AS A ROAD SURFACING MATERIAL.

By B. S. Varma, F. D. Ardagh and S. Krishna,
F. R. I., Dehra Dun.

There are considerable areas in the West Almora Division of the United Provinces which are covered with twisted *chir* (*Pinus longifolia*), and the twist is so bad that the trees are useless as timber. A certain amount of this twisted *chir* is, however, felled for the Almora fuel supply and is floated down the river Kosi to its destination, but the highly resinous wood (locally known as *chilka* or torchwood), which is obtained from stumps and roots will not float and is not, therefore, fully utilized.

In 1916, the Divisional Forest Officer started experiments to determine whether this resinous wood (*chilka*) could not be profitably used for the production of tar, by subjecting it to a crude method of destructive distillation in an improvised retort. The initial experiments met with a fair amount of success, and a profitable industry was assured when it was found that the *chir* tar so produced was quite suitable as a substitute for imported "Stockholm" tar, imports of which were at that time rendered

difficult on account of the war. Stockholm tar is produced in Sweden, Russia, and other countries, by distilling highly resinous wood in various forms of kilns with special bottoms to drain off the tar from the wood which is being carbonised. Large quantities of this tar are imported into Calcutta, where it is used in the jute mills for tarring ropes, etc.

Further experience resulted in improvements of the retorts in which the *chir* tar was produced and, as there was a profitable market for this tar in Calcutta, manufacture took place in several Divisions of the Kumaon Circle, in which abundant supplies of *chilka* were available. Production was gradually increased and reached its peak in 1919-20 when no less that 1,458 maunds were produced and even then supplies were said to have been inadequate to meet the demand.

The market began to disappear in 1921-22, as the result of a return to more normal conditions after the war, till finally production had to cease altogether, as it was found impossible to sell the *chir* tar produced.

Attempts have since been made to find a market for this tar, but it was not till 1929 that proposals were put forward to utilise *chir* tar as a road surfacing material to replace "Spramex" and proprietary compositions, which are expensive owing to the long lead from rail head. The Divisional Forest Officer and the District Engineer experimented with *chir* tar on portions of the Almora-Ranikhet road. *Chir* tar, heated to varying temperatures, was applied to sections of the road and the results were carefully observed. The experiments were not, however, very successful, as it was found that the surface broke away after a year and that the *chir* tar had then lost all its tenacity or binding power, but they indicated, nevertheless, that *chir* tar might possibly form the basis of a suitable road composition. The question was, therefore, referred to the Forest Research Institute and the problem was accordingly investigated.

For a start, a study was made of the properties of crude *chir* tar and of "Spramex" and the results are set out in the table given below: the specification for Tar Macadam as laid

down by the British Road Tar Association also being included for purposes of comparison :—

TABLE I.

	Specification for tar macadam by B.R.T.A. 1928.	"Spramex" used on roads in Dehra Dun.	*Chir* tar.
Description.—		Black semi-fluid.	Brown viscous fluid.
Fusion point (K & S method)	40·5°C	30·2°C	Below 28°C
Viscosity at 90°C (By Engler's viscometer and compared with water at 15°C)	...	390	11
Density at 28°C	1·15—1·25	1·016	1·065
Fractions:—			
Water	0—1 %	0·5 %	9·6 %
Oils up to 170°C ...	*nil*	*nil*	2·5 %
Oils between—			
170°—270° C ...	8—16 %	4·5 %	13·5 %
270°—340°C ..	12—35 % (upto 300°C only)	24·1 %	14·0 %
Totals ...	29 % (upto 300°C only)	29·1 %	39·6 %

A study of the figures obtained showed that crude *chir* tar contains a high percentage of free water and low boiling oils, which keep it almost fluid at low temperatures (20°-25°C), while its viscosity is very much below that required by the specification drawn up by the British Road Tar Association.

An attempt was accordingly made to raise its fusion point and density by removal of the free water and low boiling oils, but it was found that the product obtained was brittle and lacked tenacity and viscosity, which is one of the essentials of a good road tar. It was, therefore, decided to determine the effect of vulcanization of the *chir* tar, as it is well-known that this process imparts hardness and tenacity to materials of the bituminous and

asphaltic type. The results of these experiments are set out in the following table :—

TABLE II.

	Chir tar vulcanised at 240°C with 1 % sulphur.	Coal tar vulcanised at 240°C with 1 % sulphur.	Chir tar + 10% coal tar vulcanized at 240°C with 1 % sulphur.	Spramex received from P. W. D. Almora.
Appearance ...	Slightly plastic.	Slightly soft.	Slightly plastic.	Plastic.
Fusion point (K. & S. method) ...	48°C	39°C	44°C	35·5°C
Viscosity at 90°C ...	352	...	406	437
Density at 18°C ...	1·102	1·264	1·112	1·016

These results showed that vulcanization had the effect of raising the fusion point and viscosity of *chir* tar to a very great extent and that the best results were obtained in the case of *chir* tar mixed with 10% of coal tar. A comparison of the properties of the product obtained by vulcanizing a mixture of *chir* and coal tar with the specification drawn up by the British Road Tar Association indicated that the fusion point was still too high, while the density was too low.

Further experiments showed that the cheapest method of raising the density was to admix some coal dust, but it was also found that the time taken and the temperature at which vulcanization was carried out modified the properties of the resultant product. It was realised that proper control of the time and the temperature factors would be difficult when working on a large scale and that it would be almost impossible, therefore, to produce a uniform product with the desired properties. An attempt was consequently made to overcome this difficulty by vulcanizing a part of the *chir* tar at a low temperature (190°C) and by then adding the remainder which had only been heated to 120°C to drive off the moisture. (The amount of sulphur used in these experiments represented 1 per cent. of the total amount of *chir* tar used.) Results showed that when ⅓rd of the *chir* tar was first vulcanized and then mixed with the remaining ⅔rds, a

product was obtained closely resembling "Spramex." A serious defect, however, remained in that this product still retained 3 to 4 per cent. of moisture, in spite of the fact that 1/3rd of the *chir* tar had been heated to 190°C during the course of valcanization, while the remaining 2/3rds had been heated to 120°C to get rid of the free water. It was noticed during the course of fractional distillation of *chir* tar that water continued to come over with all the fractions, thereby showing that it was a product of the decomposition of rosin acids. In order to confirm this assumption an estimation was made of the water produced during fractional distillation of *chir* tar heated to different temperatures and for different periods, and it was found that the water produced by decomposition remained at very much the same figure (4 %), even after the free moisture had been brought as low as 0·4 % by prolonged heating. Attempts were, therefore, made to minimize the production of water by heating *chir* tar with calcium oxide, manganese dioxide and lead peroxide so as to fix the rosin acids in the form of metallic rosinates. The best results were obtained by heating *chir* tar with 1 % of lime at 170°C for 2 hours.

Having arrived at this conclusion, a composition was prepared by vulcanizing ¼ of the *chir* tar at 190°C and mixing it with the remaining ¾ which had been heated with 1 % of lime for 2 hours. The resultant composition was found to be rather too hard owing to loss of portions of the light and middle oils during the somewhat lengthy heating necessary. It was evident, therefore, that it would be necessary to get rid of the water by some other means and it was finally decided to distil the *chir* tar to a temperature of 300°C to the condition of pitch and to remove the water from the oils thus distilled by standing them over quick lime. The water free oils were then admixed until the desired consistency was obtained.

A further set of experiments was accordingly undertaken in which part of the *chir* tar was distilled upto 300°C, while the other part was mixed with a proportion of coal tar and was vulcanised with 1 % of sulphur. The original oils, which distilled over between 170°C and 300°C, were then added, but the fusion

point of the resultant product was too low so that reheating was necessary to thicken it to the right consistency. The results of these experiments are given in the table below :—

TABLE III.

	1	2	3	4	5	6
	$\frac{3}{4}$ *chir* tar distilled up to 300°C. $\frac{1}{4}$ vulcanized without coal tar. Both mixed and distilled oils added.	$\frac{3}{4}$ *chir* tar distilled upto 300°C. $\frac{1}{4}\times 5$ % coal tar vulcanized. Both mixed and distilled oils added.	The product of (2) reheated at 170°C for 1 hour.	$\frac{2}{3}$ *chir* tar distilled up to 300°C. $\frac{1}{3}$ + 5 % coal tar vulcanized. Both mixed and distilled oils added. Reheated at 170°C for 30 minutes.	$\frac{3}{4}$ *chir* tar distilled. $\frac{1}{4}$ + 5% coal tar vulcanized. Both mixed and distilled oils added. Reheated at 170°C for 30 minutes.	The product from (5) reheated for a further 15 minutes.
Fusion point (K. & S method).	25°C	32·5°C	42°C	35·5°C	37·5°C	41·5°C
Viscosity ...	...	237	525	323	337	398
Density ...	...	1·100	1·101	1·102	1·101	1·101
Fractions :—						
Water (up to 300°C).	0·4 %	0·4 %	...	0·6 %	0·5 %	...
Oils up to 170°C	0·2 %	0·2 %	...	0·3 %	nil	...
Between 170°C-270°C.	7·3 %	7·3 %	...	4·7 %	4·9 %	...
270°C-300°C ..	5·2 %	4·2 %	...	4·7 %	4·9 %	...

The best results were obtained in the experiment recorded in column 5 and a product was prepared on these lines on a semi-large scale and two samples were sent to the Government Test House, Alipore, for analysis and opinion as to its suitability as a road surfacing tar. The analyses of these two samples are given below :—

TABLE IV.

	Sample A.	Sample C.
Fusion point	39·5	38·8
Viscosity	396	412
Density	1·125	1·109
Fractions :—		
Water upto 300°C	0·6%	0·5%
Oils upto 170°C	0·3%	Nil
Between 170 and 270°C	4·8%	4·6
270 and 300°C	4·4%	5·1%
Solubility in CS_2	92·23%	97·01%

No opinion was expressed as to the suitability of this material for use as a road surfacing material, as data were lacking with regard to the use of non-bituminous products for this purpose, but the results of the analyses showed that the samples compared quite favourably with "Spramex."

At this stage of the proceedings it was decided to prepare some maunds of the tar under field conditions and Mr. T. P. Ghose, Upper Grade Assistant in the Chemical Branch of the Forest Research Institute, proceeded to Ranikhet for this purpose with a small still. There was there a stock of 185 maunds of old *chir* tar, which had been prepared somewhere back in 1921 and which had been lying in stock ever since, as no sale could be found for it. Attempts were made to utilise this material, but it was found that the final product obtained was very soft. A sample of old *chir* tar was accordingly despatched to the laboratory and experiments were taken in hand to determine whether this could be utilised to prepare the composition evolved above, which has been given the name of "Pintar." Efforts in this direction were successful and it was found that "Pintar" could be prepared from old supplies of *chir* tar and a sample analysed at the Government Test House, Alipore, agreed with the results obtained in the case of samples prepared from freshly made *chir* tar, though the out-turn was lower.

The final results obtained were so satisfactory that it was decided to give a practical trial to "Pintar" on a half mile of the Bareilly-Almora road and it was finally arranged that the Forest Department should supply 220 maunds to the P.W.D. for this purpose free of cost. A party of assistants from the Chemical Branch proceeded to Ranikhet to manufacture this supply of "Pintar" in April 1930, and two old stills, which had previously been used for the preparation of *chir* tar, were brought to Ganiadeoli, near Ranikhet, and were there converted into redistillation stills.

The requisite quantity of "Pintar" was prepared and was handed over to the Engineer on May 13th, 1930, but was not actually laid on the stretch of road selected for the experiment

(a half mile of road at mile 83 on the Bareilly-Almora road) till the first week in June. This portion of the road had last been metalled in 1926 and was not, therefore, in a very good state of repair with the result that it was difficult to clean the surface properly before the "Pintar" was applied. Just prior to and during the spreading of the "Pintar" there were one or two showers of rain so that the surface of the road was still moist at the time of spreading. When the boiling "Pintar" was applied this moisture was converted into steam and formed small blisters which prevented it from adhering firmly to the metal and these blisters tended to burst and break up into fine power, as heavy traffic passed over the road. It will thus be evident that the "Pintar" was not laid under ideal conditions.

The portion of the road so painted was inspected on October 18th, 1930, after it had been subjected to heavy traffic in the monsoon and it was then noticed that the "Pintar" had tended to dry up and crumble in places, while in others it was still in good condition. This difference was found to be due to the oil content of the "Pintar." In the case of the portions of the road which were first treated the "Pintar" was heated to 340°C and long heating was necessary to attain this temperature. During this period some of the lighter oils were driven off and it is on these portions that the "Pintar" has shown signs of drying up, while the results have been fairly satisfactory in the case of other *portions of the road on which the "Pintar" was spread at a lower* temperature.

The main drawback, however, was the comparatively high cost of manufacture of the "Pintar" which exceeded the figure anticipated as the result of laboratory tests. The easiest manner to reduce the cost of manufacture was to increase the oil constitutents in which the previous product appeared to be lacking. To attain this end further laboratory experiments were undertaken, and as a result a cheaper product was evolved without thereby impairing any of the qualities mentioned in an earlier part of this article.

After some discussion it was decided to submit this new "Pintar" to trial over another half mile of road and arrangements

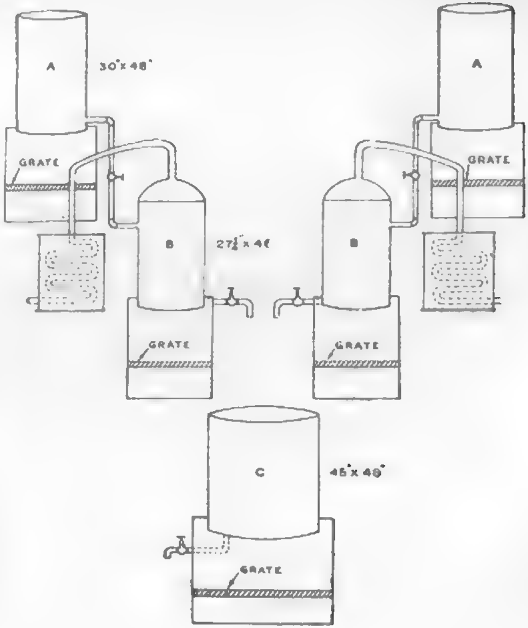
were made for one of us (B.S.V.) to proceed to Ganiadeoli to prepare the 240 maunds required.

A brief account of the method of manufacture will probably be of interest and to make the process clear a diagrammatic sketch is given of the apparatus used. The *chir* tar, in this case freshly prepared, was heated in the containers in which it was received (kerosene tins) and was then poured into the two heating tanks (A, A) through a wide mesh sieve. A fire was lighted in the grate below these tanks and the *chir* tar was then heated, with constant stirring, to a temperature of 180°C. This heating is of the greatest importance, as by this means the free water is driven off and subsequent distillation is rendered safe. It was found that it took a long time to raise the temperature of the tar to the required figure, as much as 6 hours being necessary when the whole plant was cold. As soon as the *chir* tar attained a temperature of 180°C the tap was opened and it was allowed to flow by gravity to the stills (B,B) in which it was distilled. Here the *chir* tar was distilled to 270°C to get rid of the moisture and the oils distilling over between 180°C and 270°C were collected in the condensers. This distillation only took about 2 hours to complete and the residual pitch was then allowed to flow into the vulcanizing pan (C). Here coal tar, in proportion of 10 per cent. of the weight of the pitch was added and well stirred in. Vulcanization was carried out at a temperature of 220°-240°C, sulphur (2·5 per cent. by weight) being added little by little and well stirred in. This operation took about an hour, after which the vulcanized product was allowed to cool sufficiently to permit of the admixture of the required amount of oils. These oils, obtained during the distillation of the *chir* tar and previously neutralized over lime and dried over salt, were slowly added and the whole well mixed. The resultant product was "Pintar" which was then drawn off from the vulcanizing pan and packed in containers (kerosene tins) for conveyance to the portion of the road on which it was to be laid.

It will be noticed that the first operation, namely heating of the *chir* tar to drive off the free moisture, was the most lengthy

A CHIR TAR STILL.

DIAGRAMMATIC SKETCH OF "PINTAR" PLANT.



of all with the result that the stills stood idle for considerable periods. To overcome this difficulty we suggest that the capacity of the heating tanks (A,A) be double in future plants of this kind, thereby bringing about a large saving in time and labour.

We wish to make it perfectly clear that we do not claim that this "Pintar" is suitable as a road surfacing material to replace "Spramex" and other such materials. "The proof of the pudding is in the eating" and the success or failure of "Pintar" can only be determined after it has been subjected to a prolonged practical test. In this note we have merely attempted to give an outline of the work that has so far been accomplished in the hope that it may be of help to officers who are interested in finding a market for *chir* tar.

"Pintar" can only find a use in areas where *chir* tar can be produced and then only if it can be produced at a cost below that at which other road surfacing materials can be imported. One of the main considerations, therefore, is the cost of production and we give below the probable cost of production based on figures which we have collected from actual experience, with modifications allowing for the use of a redistillation plant with preheat ing tanks of increased capacity as suggested above. A plant o this kind would in all probability cost about Rs. 1,500. In setting out the costs the figures have been so arranged under various heads that alterations can be made to suit local conditions where such charges as labour, cost of materials, etc., must necessarily vary. These figures are for a plant set up in the centre of a *chir* tar producing area and situated close to an abundant water supply, and about 2 miles from the cart road.

Estimate for manufacturing 1 maund of "Pintar" and delivery at site ready for spreading on the road.

1. Cost of chir tar.

	Rs.	a.	p.	Rs.	a.	p.
1 maund 13 seers @ Rs. 2-6-0 per maund				3	3	0

	Rs. a. p.	Rs. a. p.
*2. *Cost of ingredients.*		
Coal tar (10 per cent. on pitch) 3 seers @ Re. 0-3-0 per seer	0 9 0	
Sulphur (2·5 per cent. on pitch) 0·8 seers @ Re. 0-4-0 per seer ...	0 3 3	
Lime and salt (5 per cent. on oils)	0 0 6	
		0 12 9
3. *Working charges.*		
4 coolies on heating tanks		
1 coolie on the still		
2 coolies on vulcanization		
1 coolie for powdering sulphur, etc.		
8 coolies @ Re. 0-8-0 per day working 8 hours per day and producing 16 maunds of "Pintar" ...	0 4 0	
Fuel	0 1 0	
Depreciation of plant ...	0 1 6	
		0 6 6
4. *Supervision charges.*		
1 Forester on Rs. 40 per mensem	0 1 6	
		0 1 6
5. *Storage and carting.*		
Cartage to site ...	0 6 2	
Cost of 2 tins ...	0 8 0	
Soldering ...	0 1 0	
Depreciation on tins for crude chir tar ...	0 2 0	
		1 1 2
6. *Unforseen*	0 1 1	0 1 1
Total ...		5 10 0

*Wholesale prices in Ranikhet which is 51 miles from the nearest Railway Station.

In tabulating these figures of cost we have been at some difficulty in arriving at reliable figures under No. 5 above (Storage and Carting) as conditions are likely to vary very greatly according to the locality in which the operations are carried out. Under cartage we have adopted a figure of 6 annas 2 pies, which includes a cost of 2 annas for carrying the "Pintar" to the roadside and a freight of 4 annas 2 pies for transporting the "Pintar" to the site at which it is to be laid, allowing for a maximum distance of 10 miles on either side of the plant. On roads lorry transport will be available and we understand that the cost of carriage by this means is about 5 pies per maund per mile.

Another point that requires further consideration is the cost of the containers in which the "Pintar" is packed for carriage. In these experiments the "Pintar" was packed in old kerosene tins which had already been used for carrying pine resin. The actual charge for the tins used in this instance was 3 annas per tin, but to be on the safe side we have raised the charges to 4 annas per tin. The cost of the container is a matter of prime importance and needs careful investigation by the officers concerned.

We consider, however, that these costs are probably capable of considerable reduction. In the first instance we have accepted the cost of production of *chir* tar at Rs. 2-6-0 per maund, whereas we consider that this figure is capable of reduction. We understand that in arriving at this figure no account has been taken of the sale value of the charcoal produced during the manufacture of the *chir* tar. We are well aware that *chir* charcoal is not a very satisfactory fuel and that it is usually only used by goldsmiths, etc., and also that the charcoal produced during the manufacture of *chir* tar often contains a pitchy deposit which causes it to burn with a somewhat smoky flame. For every maund of *chir* tar manufactured about 50 seers of charcoal are produced and, even if this could be sold at only annas 8 per maund, it would reduce the cost of manufacture of the *chir* tar very considerably.

We understand, also, that no attempt is made at present to recover the other products of distillation, *viz*., the light oils and the

pyroligneous acid. A very simple condenser such as a pierced bamboo kept cool by immersion in water would enable a large proportion of these products to be recovered. The pyroligneous acid has no value and would have to be thrown away, but there are possibilities of finding a market for the lighter oils as will be seen from a study of Vol. XLV, page 112 of the "Indian Forester," in which Mr. T. P. Ghose has given the results of a study of these oils. These light oils were collected during the course of experiments carried out in 1917 and 1918 and it was then found that about 22 seers of these oils were collected for every maund of *chir* tar produced. There is at present no ready market for these oils, but we consider that a market could probably be created if regular supplies of the oils were to be available. The surplus oils which are not used for softening back during the process of manufacture of the "Pintar" are another potential source of revenue.

We have not attempted to give any prices for these oils as we do not ourselves know what they are likely to fetch in the market even when a market has been found for them. We have merely mentioned other probable sources of revenue which would be likely to reduce the cost of manufacture of the "Pintar." Every reduction in the cost of manufacture, no matter how small it may be, will give the "Pintar" a better chance of competing with other road surfacing materials in areas in which *chir* tar can be manufactured in quantity.

The oils to which reference has been made above are of the nature of rosin oils and could probably be made use of in manufacture of the following:—lubricants (oils and axle grease), printing inks, varnishes, mixtures to protect trees from climbing insects, shingle stains, waterproofing textiles and cordage, the manufacture of lamp black for lithographic purposes, soap making, leather dressings and shoe polishes, etc., etc.

Our thanks are due to the Forest Officers, Messrs. Cooper, Turner, Hira Singh and Khanna, and to the District Engineer, Naini Tal, for the assistance they have rendered us in carrying out this work and for the valuable information that they have supplied. We are also greatly indebted to Mr. T. P. Ghose, not only for the

work which he has carried out in the laboratory, but also for the valuable work which he did in preparing the original bulk supplies of "Pintar."

A SHORT NOTE ON ECOLOGICAL CHANGES IN THE FORESTS OF THE EASTERN CIRCLE, PUNJAB, AND ON THE NEED FOR A SCIENTIFIC SURVEY OF THE SOIL FLORA OF REGENERATION AREAS.

By H. M. Glover, I.F.S.

The study of plant ecology is of comparatively recent growth and most of us have left it severely alone, considering it more the province of the pure botanist than of the forest officer. We have been frightened by the abstruse terminology adopted and by the variety of definitions used by different authors for expressing identical ideas; and we have perhaps considered ecology as an abstruse science of little practical application indulged in by a number of pseudo-scientists with an unfortunate predilection for a too pedantic and entirely unnecessary phraseology to express well-known ideas. We do not even know the meaning of the word ecology, we cannot find it in the Concise Oxford Dictionary: we do not realise that plant ecology merely means the study of the plant in relation to its surroundings. When, however, we do take the trouble to master the varying definitions and nomenclature employed by the various authors we discover to our surprise that essential principles of plant relationships are clearly stated and that the botanists have provided much material of absorbing interest to the forester. As one forest officer, not one of the pre-war survivals from what the ecologists would term an unscientific age, but one possessed of some of the characteristics of the iconoclast, expressed it last summer "botany is now removed from the region of stamp collecting and has become a study useful in its adaptation to practical silviculture."

The change in soil factors during the life of a forest.

2. At last year's Forest Conference we discussed the changes in temperature and moisture of the surface soil in a deodar forest and we again touched

on this matter when examining the failure of many of our silver fir and spruce forests to regenerate. We saw that as a forest grows up the cover becomes so dense as to prevent the sun's rays from reaching the ground with the result that the temperature of the soil is lowered and the moisture content raised often to such a pitch as to render the factors of the locality unsuitable to the reproduction of the species dominant in the overwood.

Conversely where the forest is opening out, either owing to natural conditions or to the action of man and domestic grazing and browsing animals, the temperature of the surface soil is raised and the moisture reduced to such an extent that drought-resisting species alone can reproduce themselves. We want to know whether the factors of locality are suitable for the reproduction of tree species of economic value and whether it is necessary to maintain, reduce, or improve the soil factors by so regulating the cover as to permit of the correct amount of light and heat reaching the ground, the moisture retained in the surface soil being dependant mainly on the degree of its exposure to the sun.

Changes in the soil flora.

3. These changes in heat and moisture and exposure to sunlight during the life of a forest are accompanied by changes in the soil flora, which as the forest grows up consist more and more of shade bearing species which make higher demands on the soil factors. Consequently we may expect to find that certain plans of the soil flora indicate certain conditions of the soil and other factors of the locality which are favourable or unfavourable to the reproduction of tree species as the case may be. Such plans are called indicators and we shall endeavour to see exactly what factors certain of the commoner species indicate.

Degradation of the scrub forests.

4. The scrub forests in the Eastern Circle of the Punjab consist of species which in the United Provinces and the east of India form timber trees, but in the Punjab reach only heights of twenty-five to forty feet. They are subject to heavy grazing and browsing, to lopping for fodder and to abuses of every description and are

in a very degraded state as has been so ably described by Messrs. Coventry and Holland in recent monographs. The scrub forests still persist but are in an advanced stage of degradation; and the soil is hard and dry and little or no regeneration is found of species which make considerable demands on the factors of the locality. There is a continual replacement of the more valuable species such as *Anogeissus latifolia* by species of a more xerophytic type such as *amaltas* (*Cassia Fistula*), while in more degraded stages the ground supports only bushes of *Carissa spinarum*, and *Adhatoda Vasica*. There is in fact a most definite retrogression of the scrub forests of the Eastern Punjab accompanied by erosion of the surface soil. *Carissa* and *Adhatoda Vasica* are in themselves proof of the poor condition of our scrub forests and of the change in the factors which prevailed when the forests were first established.

The conifers—distribution.

5. We will now examine the conifers. There are five main species of conifers exploited for the timber market and they occupy more or less definite zones of altitude relative to one another, all species descending nearer the absolute sea level as more northerly regions are approached.

The *chir* pine (*Pinus longifolia*), occupies the lowest belt bordering on scrub forest and passing over fairly sharply to blue pine, *Pinus excelsa*. Next comes the deodar-blue pine belt, the blue pine predominating in the wet zone and the deodar in the dry zone for the reasons given in the paper on "Some factors affecting deodar reproduction" read at last year's Forest Conference. The blue pine extends both above and below the deodar and at higher elevations is mixed with spruce *Picea Morinda* and silver fir, *Abies Webbiana*. The spruce gradually disappears until the silver fir forms more or less pure woods at and above 8,000 to 9,000 feet till the birch, *Betula alba*, forests are reached. Accompanying the conifers, but generally occupying the more shady and moister slopes and nullahs, are oaks and broad-leaved trees, and it is commonly found that these species are gradually giving place to conifers, partly owing to fires and to biological

factors, of which grazing by domestic animals is the most important.

The *chir* forest.

6. The *chir* forest extends over a wide belt of the outer Himalaya and its silviculture is well-known. In recent years officers have been specially concerned with the difficulties experienced in regenerating *chir* forests lying at the lowest altitude limits of their habitat in the Kangra and Hoshiarpur divisions, where the factors of the locality have been seriously reduced owing to fires and to grazing by herds of migratory sheep and goats.

Below 2,000 feet the quality of the *chir* is very low and the stems are twisted and bent and the soil covering is chiefly *Carissa spinarum.* From 2,000 to 2,500 feet the *chir* improves, but still is of very low quality and grass increases. Above 2,500 feet regeneration is profuse amongst long grass and is easily obtained under an open shelterwood.

The *chir* seed is heavy and falls to the soil and young *chir*, seedlings flourish in long grass particularly of the species *Andropogon monticola.* The grass *Andropogon contortus* covers the more exposed slopes and indicates conditions less suitable to *chir*, whilst the *bhabar* grass, *Ischœmum angustifolium*, grows only on the driest soil of scarps and exposed ridges where the factors are ordinarily too low for *chir.* We thus have one species of grass *Andropogon monticola* which appears to indicate (*a*) conditions suitable to *chir* regeneration, (*b*) soil which will produce a fair quality of *chir.* Where the bush *Myrsine africana* appears the *chir* is of better quality: *Carissa spinarum* is characteristic of degraded areas. As the higher elevations at about 5,500 feet upwards are approached blue pine and sometimes deodar are found invading *chir* forest, a good example being the Soma Chalaon forest of Kulu. Here fire protection has allowed the blue pine and deodar to grow up under the shade afforded by the *chir* and the shade of the *chir* has reduced the temperature of the surface soil and rendered it sufficiently moist for the blue pine seedlings to establish themselves.

The blue pine forest.

7. The blue pine colonises the bare grassy slopes from 5,500 feet to over 10,000 feet elevation and also occupies burnt areas. It manages to persist even where grazing is comparatively heavy and is the most valuable pioneer species which we possess. Fodder grasses of species yet to be identified indicate conditions suitable for blue pine regeneration, which also appears profusely on bare earth and in gaps in forests where bushes and herbage are not too rank. As the blue pine which has established itself in grassy slopes grows up the grasses grow less luxuriantly and are gradually replaced by violets, strawberry, geranium, galium, ferns and and bracken, thin grass generally persisting, which, as will be seen later on, are all associates of conifers which make greater demands on the factors of the locality.

The blue pine previous to 1921 had colonised very extensive areas as a result of continuous fire protection, but in 1921 incendiary fires ravaged huge areas of forest. These filled up with indigofera, poplar, *Coriaria nepalensis, rubus, Desmodium*, willow, deutzia, etc., together with grass, bracken, *Anaphalis*, strawberry, violet, *Geranium nepalensis, Galium* and *Polygonum*, etc., and now the blue pine is establishing itself in the more open and drier portions, particularly where grazing is keeping down the rank growth. Sometimes the growth of herbage and bushes is rank and blue pine can establish itself only with difficulty and comes in first on the ridges where *Anaphalis* shows that the soil is drier: also generally under the poplar, whose light shade is suitable to the establishment of blue pine seedlings. It is interesting to note that where moisture loving and drought resisting species occur together, the soil conditions are neither too wet nor too dry for conifers to tolerate.

Mixed woods of blue pine, deodar, spruce and silver fir.

8. We have seen that as the blue pine woods close up the surface soil becomes cooler and moister and the soil flora changes from grass to violets, strawberry, maiden hair, nephrodium ferns, *Galium, Geranium nepalensis*, etc., which, as we shall see later, are associates of deodar, spruce and silver fir. Accompanying these plants are deodar, spruce

or silver fir seedlings according to altitude and moisture and temperature, and there is a constant change from blue pine to more shade-bearing tree species, a phenomenon which is of great importance to our practice of silviculture. As we shall see later many if not most of our deodar woods in the monsoon belt owe their existence to this transition from blue pine, helped largely by the artificial assistance given to the deodar by thinnings and improvement fellings. The hotter southern aspects are generally occupied by grass and blue pine, and as the latter grows up deodar seedlings appear under its shade accompanied by their typical associates, particularly on the upper sides of the trees where the young plants are sheltered from the sun. Similarly we have evidence that many of our mixed spruce and silver fir forests have originated by natural succession from mixed blue pine and fir woods from which the blue pine has now disappeared.

The deodar forest.

9. (*a*) *The monsoon belt.*—The outer hills contain little or no deodar, due apparently to the heavy monsoon rainfall. As the inner valleys are reached deodar appears generally in admixture with blue pine and is spreading throughout the blue pine forest. Generally the older deodar trees appear on the ridges, often on rocky ground, and the less steep slopes are occupied by a mass of bushes consisting of *Indigofera*, *Desmodium*, *Berberis*, *Rhus punjabensis*, *Viburnum*, etc., and herbage, which are so dense as effectually to prevent the incursion of young deodar. The growth of bushes and herbage is luxuriant and shows that the factors of the locality are of high quality: in fact so high as to enable the competitors of the deodar to outstrip it. Deodar natural regeneration, and also that of other conifers is confined to the ridges, where bushes and herbage are less luxuriant and do not choke the young seedlings. Before we can expect deodar to grow here we must so lower the factors of the locality as to enable the deodar to withstand competition. We do this by cutting and burning the bushes and sometimes by encouraging grazing. In such places it is essential to sow and plant deodar and not to wait for natural regeneration in order to give the deodar plants a start over their competitors.

We find deodar regenerating naturally in gaps in deodar forest and particularly under the shade of blue pine trees. If we examine the soil flora we notice at once that it is scantier, and although we may find some of the same species as in the patches of dense bushes and herbage discussed above, they are not growing luxuriantly. The deodar seedling is commonly associated with violets, maiden hair, fern, strawberry, thin grass, *Geranium nepalensis* and *Galium*, all species which show a fresh and fairly moist but well drained soil. This association is found in such widely separated localities as the Kagan Valley, Chamba, Kulu, Seraj, Bashahr, Chachpur and the Balsan States. *Indigofera, Desmodium, Viburnum* and bracken are often present under the shade of the trees but are suppressed and care must be taken not to open the overwood in seeding fellings to such an extent as to allow them to gain the upper hand. Seeding fellings must be light so as to enable the deodar to be firmly established before secondary fellings are made.

Throughout the inner hills in the south-west summer monsoon belt the greatest enemies of the deodar are weeds and bushes, and when seeding fellings have been made at times when there is no seed on the trees deodar must be introduced artificially before the weeds and bushes have established an ascendancy. One of the most interesting types with which we have to deal is the *nirgal* bamboo (*Arundinaria falcata*) and the *machilus* type, both these species indicating of very moist and rich soil conditions in regions of heavy rainfall and generally associated with the *ban* oaks (*Quercus incana*) and other broad-leaved trees. The deodar rarely is able to establish itself naturally in such areas but when it appears sporadically it attains immense dimensions. In the Hurla valley of the Kulu Division heavy cutting and severe burning followed by sowings have allowed deodar to be established over a large area, while at Chachpur transplanting, though expensive, after girdling oak has proved successful. We have noted above that bushes are generally present under a deodar overwood although they are suppressed: weeds are prolific bearers of seeds which are often dispersed by the wind and invade all bare areas rapidly; consequently it is of prime importance to obtain a clean seed bed

for the deodar and this is accomplished by burning the refuse of fellings which destroys bushes and the latent seeds of weeds already in the ground.

As the monsoon belt recedes we find that more drought resisting species such as *Plectranthus rugosus* occupy the lower deodar belt and deodar regeneration is difficult to obtain on account of the dry surface soil. We have to maintain the deodar cover and so regulate our seeding fellings that the maximum shade is afforded to the seedlings by proceeding in an anti-sun direction. We find that the cutting and burning of bushes and the burning of refuse adds much receded ash to the soil which stimulates the growth of the deodar seedling and enables it to push down its roots rapidly to keep touch with the receding soil moisture during the prevailing drought of April, May and June.

(*b*) *The dry zone.*—As was seen last year the deodar is essentially a snow plant and germinates early in the spring and is dependant largely on the moisture from melting snow. As the dry zone is approached fresh species are met with. The Ilex oak (*Quercus Ilex*) displaces the *ban* oak and *Pinus Gerardiana*, the *chir*. Deodar grows best at from 8,000 to 9,000 feet and often forms pure woods, the mixed blue pine and deodar forest occurring at higher elevations and the fir forest, which covered vast areas in the monsoon belt, now forms a less marked feature of the landscape.

Accompanying this change of the distribution of tree species is a corresponding change in the soil flora. *Caragana*, *Artemisia maritima* and species of *Astragalus* are found on the lower and drier slopes, but it is interesting to note that higher up the hills the violet, strawberry and their associates are found amongst deodar and blue pine seedlings, showing that the climate becomes moister and cooler with increasing elevation. Grass has disappeared from the lower slopes and herbage and bushes are far less plentiful than in the monsoon belt. *Caragana* and *Artemisia* indicate soil conditions where deodar reproduces itself only with great difficulty, if at all, and grows exceedingly slowly, whilst the presence of the violet, strawberry, etc., and the blue pine indicate conditions favourable for deodar reproduction. The plant Aarons

rod (*Ainalsa aptera*) when found in established deodar forests at higher elevations shows that the soil is of high quality. Similarly for maiden-hair and the ferns. *Thalictrum javanicum* extends over a belt of several thousands of feet, but within the deodar zone appears to indicate conditions suitable to deodar regeneration.

The general absence of dense bush growth enables us to make seeding fellings more heavily without the risk of incursion of bushes, but at the same time we have to be very careful so to arrange our fellings as not to increase desiccation by exposing the soil unduly to the direct rays of the sun. We have in fact to be very careful to ensure that the factors of the locality suffer no diminution; we find that the burning of refuse in small heaps stimulates the growth of the deodar seedling by reason of the addition of ash as manure to the soil.

Aspect has to be studied carefully when making our fellings as the least change in aspect has a considerable effect on the temperature of the surface soil. This is reflected in the soil flora: between Shimoling and Purbani in Kanawar: strawberry, ferns and geranium were found on cooler slopes in a mixed deodar and *kail* forest at between 9,750 and 10,500 feet elevation, whilst *Caragana* was met with on slopes exposed to the sun, showing that even at these high elevations drought and heat are still to be feared.

In the dry zone the persistence of species common in the monsoon belt is of more than purely botanical interest as these species afford proof that where they occur conditions are moister and favourable for the reproduction of conifers.

In the arid zone towards the Thibetan border deodar virtually disappears and such trees as do exist grow in isolated positions; there is no reproduction and the soil flora is very scanty and consists solely of xerophytic species.

The spruce and silver fir forests.

10. The spruce and silver fir forests form a continuous belt at high elevations immediately below the birch forests and alpine pastures. The spruce is mixed with the silver fir at the bottom of the fir zone and generally prefers a warmer and drier

soil. This is only a question of degree and for the purposes of this note the silver fir alone will be discussed. The silver fir shows a marked tendency to invade blue pine forests into the higher belts of which it is extending rapidly throughout the monsoon zone and it is certain that many of our fir forests have originated from blue pine woods.

The silver fir is invading the cooler and moister deodar forests in a similar manner; it is invading the high level oak (*Quercus semecarpifolia*) and the lower portions of the birch forests and generally is spreading in broad-leaved forests, where it first occupies the ridges. We often find the fir seedling associated with ferns, of the nephrodium type, with the maiden hair fern, violet, strawberry, thin grass, Aarons rod, etc., and in fact many of the species which are associated with the deodar seedling. These indicate a fresh, well drained soil.

As the fir forest grows up Aarons rod, ferns, *Chalictrum* and herbs which have not yet been identified appear (the lilies and *Buplurum*, *Inula*, *Stellaria*, etc., would repay study) and the soil appears to be fresh; but with advancing age the soil becomes cold and wet, thick humus is formed and the soil flora consists of shade bearing balsams and strobilanthes and no silver fir seedlings whatever seem able to persist. The yew (*Taxus baccata*) appears together with maples, *Viburnum* and other broad-leaved species and bushes. It appears probable that after the broad-leaved species have formed a forest the silver fir will appear once more. Where slips have occurred the fir seedling grows on the exposed soil. It appears to be certain that we must reduce the factors of the locality in order to re-establish the fir.

Opening the cover in seeding fellings merely results in stimulating the growth of strobilanthes; with a heavy opening at the top of the Nala bon forest in Lower Bashahr, followed by an accidental fire in 1921, the soil flora had completely changed by 1928 and *Rubus* and its associates covered the ground and some silver fir regeneration is appearing. We have made only a very few sustained attempts to regenerate mature fir forest

and the most interesting are in the Kulu division, particularly at Pulga, where comparatively heavy shelterwood fellings were made in 1915, and where by 1930 fir seedlings had appeared on the ridges and drier portions. This satisfactory result was achieved by adopting measures similar to those practised in deodar forests. Shelterwood fellings, which let in the sun and reduced the factors of the locality, were followed by burning the refuse from exploitation and forming a clean seed bed. This reduction of the factors of the locality and the formation of a clean seed bed, preferably by a fairly severe fire, appear to be essential for obtaining regeneration in a mature fir forest. It appears also to be most desirable to prevent the extermination of broad-leaved trees in a fir crop as their presence prevents the formation of a deep raw humus and keeps the soil sweet and moderately moist and in good condition for natural regeneration.

The transition from broad leaf forest to conifers.

11. The invasion of broad leaf forest by conifers is a natural process and we find silver fir extending rapidly into the *kharsu* oak (*Quercus semecarpifolia*) birch and maple forest; the deodar into *Quercus Ilex* and *Quercus incana* forest; and in fact a general increase of the conifers at the expense of the broad-leaved trees. As the conifers grow up they form a canopy above the broad-leaved trees, which sometimes is so close as to kill out the more light-demanding species, with the result that more or less pure coniferous woods are eventually formed. This transition was checked in olden times by continual forest fires.

The conifers make lower demands on the factors of the locality than do the broad-leaved trees; and, as broad-leaved forests are heavily lopped and grazed over, the transition to conifers is accelerated as is evident in the *Quercus dilitata* oak forests near villages which are frequently changing to blue pine or deodar. The actions of man and the grazing of domestic animals lower the factors of locality and degrade our forests except where special protection is afforded, with the result that the factors are frequently too low for the reproduction of broad-leaved species but are often suitable for conifers.

12. Fire is used largely as a means of disposing of the refuse from fellings, and the ash supplies a valuable manure to the soil with the result that not only is the growth of plants, including conifers, stimulated, but species of the soil flora appear which make higher demands on the factors of the locality. In Purbani Cpt. 40C of the dry zone the burning in 1917 of refuse from shelterwood fellings resulted in a partial change from *Caragana* to mullein by 1928. Where, however, in Barang Cpt. 37 a fire in 1924 had been too severe the soil had been so heated that it had been sterilised and was covered only by thin moss. In Purbani Cpt. 40D an accidental fire of 1918 had so exposed the soil and so reduced the factors of the locality that by 1928 deodar seedlings had failed to re-establish themselves. Fire in the moist zone is useful as a means of changing the factors of locality to a degree suitable to conifers and as affording a stimulus to growth; but where the soil is already dry there is a risk that the fire may be so intense as to reduce the soil factors below the standard required for conifers and their associates. This condition certainly prevails at the lower elevations of the *chir* belt where fires may reduce the factors of locality below the standard required by the young *chir* seedling. Forest fires have again broken out in Lower Bashahr and the opportunity for studying the changes in the soil flora should not be neglected.

The effect of fire on the factors of the locality.

13. Grazing generally lowers the factors of the locality, as already mentioned in previous paragraphs. Where the soil factors are already low grazing reduces them still further and tree species cannot regenerate, as we have seen in the scrub forests and as is happening in many other forests throughout the Himalayas. In the blue pine forests burnt in 1921 dense bushes appeared and grazing is stimulating the invasion of blue pine seedlings. In the deodar forests of the dry zone heavy grazing has frequently lowered the soil factors below the stage at which deodar seedlings can maintain themselves; similarly in drier parts of the moist zone; but elsewhere grazing frequently lowers the factors of locality to an extent which permits deodar seedlings to be established in areas where

The effect of grazing on the factors of the locality.

without grazing they would have no chance of survival. Kharshali of the Upper Pabar is an interesting example of the change from mixed spruce and deodar to deodar, *vide* extracts from field notes given below:—

"The portion below the camping ground at 8,000 feet is of particular interest and shows the transition of a mixed deodar and spruce forest to almost pure deodar. This is due largely to the girdling of spruce and to grazing which has kept down the weeds.

The soil flora contains in addition to geranium, *Desmodium*, violet and a little grass, etc., certain species indicative of moister conditions ordinarily suitable more to spruce than deodar *viz.* bugle, some strobilanthes, some *Pedicularis gracilis* and *megalantha*, some *Polygonum* and dock."

Diudi, Upper Pabar, is an example of deodar growing where normally one would expect fir.

Similarly in fir forests grazing in Upper Kulu is preventing the regeneration of silver fir and spruce near villages: also in the Kagan high level fir forests, where the grazing is very heavy indeed and where there is no *Quercus semecarpifolia* oak. Elsewhere in mixed broad-leaved and fir forest grazing is often certainly one of the main cause of the regeneration of silver fir. (*a*) As examples may be quoted the fir forest below the Brua pass in Kilba range where the grazing is so heavy as to cause the destruction of the birch forest; nevertheless the adjoining silver fir forests is regenerating profusely. (*b*) The *Quercus semecarpifolia* forest near Daran where silver fir seedlings are coming in densely under the blue pine and *kharshu* oak, although the forest is heavily grazed. The soil flora consists of violet, strawberry, geranium, fern, etc., some oak seedlings and *Viburnum*. (*c*) The short cut to the Basles pass in Kurpan range where the silver fir is dense below the heavily grazed bushes.

The soil flora is of importance as indicating whether grazing is or is not desirable according as to whether the factors of the locality require to be raised or lowered by grazing in order to afford an opportunity for mesophytic species such as conifers to enter.

14. The first qualification of a plant for use as a soil indicator is that it shall be easily recognisable. Foresters are rarely expert botanists and cannot be expected to recognise any but the more common and well-known species. Secondly, it must persist for a considerable period and not, as often happens, be present for only a very short season. Thirdly, it must indicate definite conditions of the soil and must not, as in so many of the *Compositæ*, accommodate itself to a great variety of soil conditions.

Qualifications of soil indicators and their interpretation.

The conifers are mesophytic species and regenerate best on fairly well drained soils, conditions suited to a very large number of species but amongst which strawberry, violet and maiden-hair, fern and their associates together make approximately the same demands on the surface soil as do the seedlings of most of the conifers within their own habitat. The luxuriance or opposite condition of the herbage affords an indication of the degree of moisture in the soil: where moisture loving species grow luxuriantly the young conifer cannot compete with the herbage whereas where the same species persist only in an attenuated condition the young conifer outstrips its competitors. Drought resisting species are useful in the moist zone as indicating that the soils of particular areas, such as ridges, are drier than neighbouring soils; whilst monsoon region species in the dry zone are of the reatest value as proving that the soil possesses the minimum of moisture necessary for a coniferous seedling to flourish. The aid which is afforded by the soil flora is of prime importance to an understanding of the silvicultural condition of our forest: we are able to recognise whether the factors of the locality are too high and require reduction before conifers can regenerate, or whether they are too low and the forest requires rest and protection to restore the surface soil to a condition in which reproduction can be re-established. The subsequent growth of the trees is dependent not only on the condition of the surface soil but more particularly on the depth, condition and moisture content of the sub-soil. The study of the extent to which the soil flora indicates the quality of the timber is not sufficiently advanced, but it may be noted that *Artemisia* and *Caragana* indicate the lowest quality of deodar;

Aarons rod and the maiden-hair, fern, a high quality, that a potentially very high quality obtains where the moisture loving oaks, broad-leaved trees, *Machilus* and *nirgal* bamboo are present. It s certain that it would repay us to study the relations between the deeper rooted species of the soil flora and the quality of the timber crop.

15. *The Soil.*—We saw last year that the geological formations of the Himalaya are such as to produce soils suited to the growth of deodar; similarly for other conifers. Certain trees show a marked preference for certain geological formations, of the *chir* which flourishes on quartzite, on which other conifers do not attain their maximum development: also the deodar, which avoids Tertiary sandstones and clays unless there is an appreciable admixture of limestone. We may expect to find similar reactions of the plants composing the soil flora, but as yet their relations to the soils derived from the various rocks have not been worked out.

The soil of our forests is our capital and is "a delicate instrument that is easily exhausted and rendered infertile." On our treatment of the surface soil of our forests depends not only the fertility of the forests themselves but also the fertility of lands often lying far away. If we expose the soil unduly to the heat of the sun and to the heavy monsoon rains it becomes infertile owing to desiccation or to leaching. On the other hand exposure of a saturated soil with an acid humus to changes in temperature by the direct action of the sun's heat causes the acid humus to decompose and entirely alters the composition of organic acids which are inimical to plant growth. The surface of the soil of our forests is irregular and this very irregularity is of advantage as it assists in drainage. "Water is the "general solvent and removes in solution enormous quantities of "the constituents essential to plant growth. This process would "in time leave only insoluble materials, and the soils would be "barren and useless. The earth is saved from this fate by the "refertilisation of the soils from the primary rocks of the interior "which are rich in lime, alkalis and phosphorus" (Gregory.—The Machinery of the Earth. Nature, December 1930).

If we allow the soil to be eroded and washed away we lose the most valuable part of our capital. Not only is the chemical composition of our soil of importance but also its texture. A hard compacted soil is unsuitable for vegetative growth. We find that each change in the soil constitution and texture is rapidly reflected in the soil flora: conversely by examining the constitution of the soil flora we are able to ascertain the condition of the soil.

Accompanying changes in the soil are corresponding changes n the bacterial and animal population of the soil of which we know very little indeed; but our scientific study of the soil flora and the composition of the soil will not be complete unless we examine also the relations of the soil fauna to plant growth. The field of study is wide and workers are few; but now that we have a Research Branch it behoves us to make a commencement in this absorbing and interesting line of research.

Conclusion.

16. This note has been written to show the need for investigating the soil flora of our regeneration areas and of our forests generally and outlines the help which we may expect to obtain from a study of the plant associates of our main species. It makes no attempt at an exhaustive study of the soil flora, such as would be undertaken by a pure botanist, and it has purposely been confined to the commoner species such as can be easily recognised in the field.

Notes on the flora of individual forests and on the changes in forest types taken by the writer during the past two or three years are being handed over to the Research Officer for help in continuing the investigation. It is hoped that Forest Officers generally will interest themselves in this line of research as it appears that a more detailed knowledge of the soil flora will assist the solution of many of the silvicultural problems with which the Department is at present confronted.

The writer wishes to acknowledge assistance in the field from Messrs. Gorrie and Hamilton, I.F.S., and Forest Ranger Khan Sultan Mohammad.

(*The above paper was read at the Punjab Forest Conference held at Lahore in 1931—Hon. Ed.*).

SOME METHODS OF TESTING THE COMPARATIVE DURABILITY OF INDIAN TIMBERS IN RELATION TO TERMITE ATTACK

BY CEDRIC DOVER, UPPER GRADE ASSISTANT, ENTOMOLOGICAL BRANCH, F.R.I., DEHRA DUN.

In a recent article (February, 1931) in this journal, F. J. Popham discusses the utility of the so-called graveyard method of testing the comparative durability of timber, reaching the conclusion that it "can only serve to eliminate the unfit and emphasize the excellent". As we shall see below, however, graveyard tests do not always do even this, and his article shows that the method does not satisfy the increasingly exacting standards of modern applied science. A new technique, therefore, is necessary; and the following comments are intended to provoke a discussion which may contribute to its development.

Mr. Popham's article consists largely of criticisms of the functions of such variables as uncontrolled variability and periodicity of the food-supply in the test-yard, the influence of enemies, such as ants, on concentrations of termites, area-variations, the idiosyncratic behaviour of various preservatives and the present inability to apply them uniformly. Of these, the enemy-factor (using the term 'enemy' as distinct from 'parasite') may be regarded as unimportant, since termites are normally of gregarious habit and have a special caste—the soldiers—whose main function is the protection of the colony. Moreover, the common ants of the graveyard in New Forest belong to a typical harvesting species (*Phidole indica* Mayr.) and are preyed upon by a hunting ant (*Dorylus orientalis* Westw.) which also occurs in the graveyard. (Lefroy, 1909, pp. 326-327.)

But the other variables, and there are many more than those which Mr. Popham enumerates, clearly prove that graveyard tests cannot be regarded as providing reliable or even approximate indices to relative durability, much less to what may be called actual durability. In fact, if he can say 'to an enquirer for practical results' that a certain species 'may last from 2 to 5 years' he has more information than one would expect the graveyard tests to provide. It is a matter for congratulation rather than complaint.

Before proceeding further we may examine the objects of the graveyard tests, a matter which is not considered in R. S. Pearson's three monographic papers (1912, 1915, 1922). Unreliable though the graveyard is for determining the influence of a single important factor affecting the durability of timber, it is said to serve as a test not only against termites but also against fungi and borers and 'is a sort of weathering test as well'! This statement is based on the assumption that stocking a small yard in Dehra Dun with a heterogeneous collection of stakes, both untreated and treated with a large number of different preservatives, will provide data which can be applied throughout India.

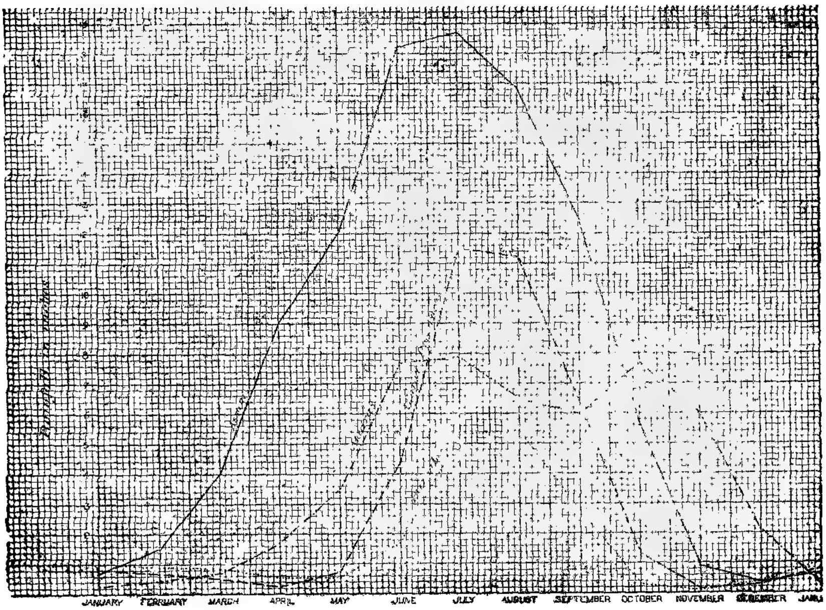
To leave the fungi (there are no borers likely to attack test stakes) out of consideration, this assumption involves the belief that for practical purposes a white ant, as J. Assmuth (1913) puts, it is a white ant, meaning thereby that all termites are alike and affect wood in the same way throughout the country. Actually, however, there is a very large number of species of termites, many of them undescribed, in India which can be classified under markedly different groups according to their habits. The habits of some species are definitely specific; of others they are variable. Thus, *Odontotermes obesus* Ramb. (Holmgren, 1913, p. 108; 1912; 1917), the common termite of the plains of India, is typically a mound-builder (Annandale, 1923, 1924), but frequently its nests do not appear above the ground (Lefroy, 1909, p. 120), as is the case in the graveyard in New Forest, where it appears to be the only abundant termite.

This species is attacking wood in the graveyard, but it is nevertheless only an occasional wood-eater (Assmuth, 1913), an observation which is supported by the fact that the records of the Wood Preservation Section, Forest Research Institute (which Mr. Popham has kindly shown me) prove that its attacks are not continuous, long intervals sometimes occurring between one attack on a particular stake and another. Moreover, Fletcher and Ghosh (1921) point out that treated wood at Pusa had a much shorter life than at Dehra Dun, this being probably due to the fact that the species attacking it was different from the Dehra species. This emphasizes Fr. Assmuth's

contention (now generally admitted) that the first essential in such experimental work is to identify the species used, as a preliminary to knowledge of its biology. For, unimportant though morphological differences may appear from a practical standpoint they are often correlated, as G. F. Hill (1930) points out, "with such profound differences in feeding and nesting habits that some species may be rightly regarded as beneficial insects, whilst others range all the way from minor pests to pests of outstanding economic importance." Had the habits, therefore, of the local termites been known when the Institute's graveyard tests were initiated, it may have been possible to avoid the criticism of having used a termite of little importance instead of one which is a serious destroyer of timber. As it is, the unfortunate 'enquirer for practical results' who has been informed that a particular wood 'may last from two to five years' may find, if it is attacked by a species such as *Leucotermes indicola* Wasm. or *Coptotermes heimi* Wasm., that it is useless after six months.

The Institute's graveyard tests, therefore, have not even the merit of being intensive, and such information as that reported by F. D. Ardagh (1930), as he himself admits, must accordingly be regarded with much reservation. But if they were intensive the results afforded by them could not be regarded as a sort of *vade-mecum* for the rest of India. Termites are remarkably responsive to physical factors, and intensity of attack, even where the same species is concerned, consequently varies considerably in various parts of the country. We are apt to overlook, though we know the variability of the Indian climate, just how much it does vary. For emphasis, I have therefore plotted in the accompanying diagram the normal monthly rainfall (Walker, 1924) in four major divisions of the country. No one who knows the sensitiveness of termites to temperature and humidity would expect even properly controlled, intensive tests carried out in any one of these divisions to be applicable in any one of the others, though results obtained in such places as the Punjab and the United Provinces may be fairly similar.

From the above it appears that durability tests undertaken for the reasons now underlying them must be regarded as outside



Normal Rainfall of Four Divisions in India.

the scope of the immediate research programme of the Forest Research Institute. For reliable data on the durability of various timbers can only be obtained, as Mr. Popham suggests, from a number of graveyards (in which such variables as uncontrolled variability and periodicity of food-supply are eliminated) installed in decentralized test-areas 'placed within the range of the economic exploitation of the species'. The resources of the Forest Department make such a project feasible, but to attempt it without the experience gained from preliminary research, without properly standardized methods, would be an unwise and uneconomic procedure. It is a lay opinion, but it seems as if this preliminary research should begin with studies on the relative susceptibility of various timbers to termite attack and the comparative efficiency of various preservatives. The rest of this note, therefore, deals with methods which may be worthy of consideration in connection with these initial studies. They are essentially modifications of the graveyard tests in which undesirable variables are eliminated and a 'constant' introduced.

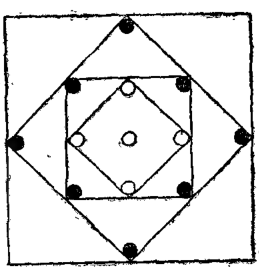
In Australia, where investigations on termites and methods of wood preservation are in an advanced stage (Cummins, Dadswell and Hill, 1930), a rapid method (Hill, 1930a) of grading timbers according to their susceptibility or resistance to termite attack has been found in the use of laboratory colonies of *Eutermes exitiosus*, a species 'which does considerable damage to timber structures generally.' Briefly, the method consists of half-filling cylindrical jars with the woody, honeycomb material from the interior of the nest together with a "smaller proportion of the earthy matter composing the outer walls. The material thus collected usually contains a sufficient number of termites to stock the jars", which are then kept, with the lids screwed down, in an underground chamber. Colonies have been maintained in this way for periods up to six months under favourable conditions of temperature and humidity.

Pieces of the woods to be tested are placed within the jars and the results noted, it being said that satisfactory tests were completed in about three weeks. On the value of the tests Hill writes that it has been possible "to prepare a provisional list of commonly-used timbers, arranged according to their resistance or susceptibility to termite-damage; and this information has been made available already to users of local material. When these results have been more completely checked up with service tests in the field test plot......and the investigations have been extended to include a wider range of commonly-used timbers and a wider range of economically-important termites, the information should be of considerable practical value in the selection of timber for such purposes as telephone poles, fence posts, etc., particularly if it be accompanied by accurate information as to the distribution of termite species."

So far success has only been attained with *Eutermes exitiosus*, fortunately an important species, but further work is proceeding and it is hoped to establish laboratory colonies of other species also. A similar investigation is included in the current research programme of the Forest Entomologist, Forest Research Institute, but attempts to establish laboratory colonies of *Odontotermes obesus* have not yet met with success. One lot of

individuals, however, remained alive in a covered glass trough for three weeks and fed slightly on bamboo pulp, eventually succumbing to a prolific growth of fungi and moulds (Bose, 1923) in the trough. We are, therefore, optimistic of success when the necessary conditions of temperature and humidity can be provided , and the growth of fungi can be controlled. The control of fungi, however, may prove a difficult problem, since it has been found that *O. obesus* cannot live in screw-capped jars for more than a few hours and the fungi, which are kept in control under the conditions found in a termites' nest, gain the upper hand on exposure to the air.

Other methods of grading woods according to their susceptibility or resistance to termite attack are therefore being explored by the Forest Entomologist. Experimental plots (6′ x 6′), which are baited with thirteen cubes of *Bombax malabaricum* (arranged as in the accompanying diagram), have been started in the garden attached to his Insectary. When termites are actively working on the baits, which can be regarded as a constant, the five innermost baits in each plot will be removed and replaced with similar cubes of the timbers to be tested. In control experiments, the removed baits are replaced with fresh baits of the same wood. When



this stage has been reached, it is expected that recording the results of fortnightly inspections will provide data on the comparative susceptibility of timbers in relation to the species of termite concerned, and that in some cases the order of the timbers so graded will remain the same even when experiments with other species of termites are conducted. In other words, it is supposed that the order A, B, C, D, will be relatively the same though the intrinsic values of A, B, C, and D may be different. This, however, is merely a supposition. It is possible, in fact in some cases almost certain, that a timber which is unpalatable to *O. obesus* may be attacked as readily by a more vigorous and habitual wood-destroying species as *Bombax malabaricum* is attacked by *O.*

obesus. Our experiments, therefore, will have to be widely repeated before any universal value can be attached to the data obtained. They must also be supported by experiments in which lots of mixed woods are exposed to attack by termites.

We come now to investigations on the efficiency of preservatives. The use of preservatives, an expensive and not always a satisfactory method, must predominate in wood-preservation technique in India until we have the results of basic studies on the taxonomy, distribution, and biology of termites, supported by protozoological and bacteriological studies having for their object the control of termite-attacks by the destruction of their cellulose-digesting commensals (DeMello, 1920; Yonge, 1925). Without such investigations consideration of other, and perhaps more economic, control measures is not likely to be fruitful. In Australia, the alert Council for Scientific and Industrial Research has realised the need for such investigations; in India it needs to be emphasized, and the Forest Entomologist's proposals to employ the services of an experienced termitologist should be supported by those who are concerned with the preservation of timber. An article on the economics of termite damage would be a useful preliminary to such propaganda. In this article estimates of the damage done to living trees should be included, for attacks by termites are not limited to cut timber as is sometimes supposed. In Malaya, for example, *Coptotermes curvignathus* Holmgren, misidentified as *Termes gestroi* (Pendlebury, 1930), is the most serious pest of rubber-plantations (Pratt, 1909).

Our experiments on preservative efficiency take into consideration the fact that preservative-efficiency tests under exposed conditions (which were originally started for sleepers) provide no index to the value of certain preservatives, such as those which contain soluble salts, for treating ornamental woods and timbers which are used in indoor construction.* And there is a possibility of economic advantage in using one preservative (which may be useless for exposed timbers) for such woods and another for exposed timbers. Moreover, the proximity of a large number of

* The ideal, of course, would be to conduct indoor tests for such timbers with a species of termite such as *Leucotermes indicola.*

stakes treated with a very wide range of preservatives, as is the case in the Institute's graveyard, introduces factors, such as leaching out, which it is thought desirable to eliminate. In this connection it may be mentioned that the hydrogen-ion concentration of the soil in this graveyard, in the vicinity of treated stakes, has been found by Mr. Popham to be pH. 7.5, while that of soil in other parts of the graveyard and in the vicinity is pH. 7.2.

We are therefore using galvanised iron trays ($2' \times 2' \times 5''$) with removable lids and wide-meshed, wire-gauze bottoms for our experiments. These trays are placed and fixed on the ground with a thin layer of soil covering the wire-gauze, and each of them is then baited with eight cubes of *Bombax malabaricum*, which have been found by experiment to be rapidly attacked in such situations. The presence of termites actively working on the baits is again regarded, for practical purposes, as a constant. Each tray tests the efficiency of one preservative by the addition of a treated cube of *Bombax malabaricum;* and the experiments are done in parallel series, one with the trays covered and the other with the trays uncovered. The results of fortnightly inspections are recorded, and it is hoped that the continuation of such investigations will provide a table of the comparative efficiency of a wide range of preservatives under exposed and protected conditions. These experiments will, of course, have to be supported by further investigations, as for example those which consider the correlation between the utility of preservatives and the characters of various timbers, but the results of the initial experiments, when considered in relation to cost, should narrow the scope of such investigations to workable proportions.

On the entomological side, other studies are also necessary if a sound basis for the development of a new technique for testing the durability of timber is to be provided. Such studies are being considered by the Forest Entomologist. A beginning has been made with experiments designed to investigate the seasonal incidence and behaviour of the local soil termites and the effects of an increasing wood-supply in restricted areas, such as the graveyard or a storage shed, It is only after

step-by-step researches, researches which involve the co-operation and criticisms of workers in widely different branches of science and industry, that we can hope to develop a scientific wood-preservation technique and methods of testing its efficiency. In wood-preservation, as in any other branch of applied science, there is a danger in too much practicality, in utilising the hit-or-miss methods of the so-called practical man. We must progress in close, correlated stages to those extensive field-experiments visualised by Mr. Popham.

Acknowledgments.—*This note owes its origin to suggestions and criticisms offered by Dr. C. F. C. Beeson, Forest Entomologist, Forest Research Institute, during discussions concerning the termite-investigations initiated by him as the result of enquiries by Mr. F. J. Popham, Officer-in-charge of the Wood-Preservation Section of the Institute. Mr. J. C. M. Gardner, Systematic Entomologist, has kindly identified the ants and termites collected in the Institute's graveyard.*

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[Mr. Dover appears to have overlooked the fact that the old graveyard tests at Dehra Dun were started to give a very rough indication of the comparative merits of various wood preservatives. The tests had a definite value, but they were never intended to furnish detailed data on termite damage. The fact that many thousands of sleepers, both treated and untreated, of many species, have been under observation in almost every quarter of India during the past 16 years is also not mentioned in Mr. Dover's note. These omissions are mentioned, in case a wrong impression of the very useful work done by the Forest Research Institute should be conveyed to readers of the "Indian Forester" who are not conversant with the work of the Wood Preservation Section.—HON. ED.]

NOTES ON PINUS GERARDIANA.

By A. E. Osmaston, I.F.S.,

Principal, Forest College.

In an article with the above title which appeared in the "Indian Forester" for May, 1931, Mr. R. M. Gorrie says that this pine is found in inner Garhwal. On referring to Professor

Troup's *Silviculture of Indian Trees* I find the author here also states that the pine is found in the Niti Pass in Garhwal. *Pinus Gerardiana* is, however, I am convinced not found anywhere in British Garhwal. I may be permitted to quote here what will be found on page 563 of my *Forest Flora for Kumaon* 1927:— "Dr. Brandis in his Forest Flora gives Dr. Jameson as his authority for stating that *Pinus Gerardiana* Wall occurs between Malari and Bampa in the Niti valley and this statement has apparently been copied by subsequent authors though J. L. Stewart in his Punjab Plants says that the dried specimens from this area at Saharanpur hardly agree with *Pinus Gerardiana.* I was twice in the locality and failed to discover any pine except *Pinus excelsa* though I made a close search and I feel convinced therefore that *Pinus Gerardiana* does not occur."

BIRTHDAY HONOURS' LIST.

We offer our congratulations to the following Members of the Forest Department who figure in the recent Honours' List published in the Gazette of India (Extraordinary) of 3rd June, 1931:—

COMPANION OF THE INDIAN EMPIRE.

Charles Adolf Malcolm, Esquire, Indian Forest Service, Chief Conservator of Forests, Central Provinces.

SARDAR SAHIB.

Sardar Bahadur Singh, Extra Assistant Conservator of Forests, Punjab.

KHAN SAHIB.

Saiyid Manzur Husain, Forest Ranger, United Provinces.

AHMUDAN-GAUNG-TAZEIK-YA-MIN.

U Chit Tin, Burma Forest Service, Extra Assistant Conservator of Forests, Depôt Assistant, Government Timber Depôt, Rangoon, Burma.

THE MAIN RESULTS OF THE SWEDISH NATIONAL FOREST SURVEY AND A SHORT DESCRIPTION OF THE METHOD EMPLOYED.

BY ERIK THORELL.

The above article was received for publication in the "Indian Forester" but unfortunately it was too long for inclusion in its original form. The following account describes briefly the main points of interest.

For several years before the war an inventory of the forests of Sweden, one of the most valuable forest territories of Northern Europe, had been contemplated. Various rough estimates of the timber supply of that country had been made previously, but the results varied considerably owing to incomplete basic data and to the crudeness of the methods used. The present investigation, which constitutes one of the largest and most comprehensive statistical investigations that have been carried out in the history of European forestry, was completed between the years 1923 and

1929, during which time the whole of the forest area of the country, including both private and state-owned forests, was covered by a system of strip enumeration surveys with a view to obtaining reliable data of the quantity of timber available of all diameter classes down to 10 cms., the areas of forest land that contained productive forests, bog, pasture land, rock, and blanks, etc., and the rate of increment the forests were putting on throughout the country.

The method employed was an adaption of the old Swedish system of strip enumeration surveys. Before starting the enumeration exhaustive tests were made to ascertain what width and espacement of the strips would give sufficient accuracy of enumeration combined with least expenditure. Strips 10 metres (roughly half a chain) in width spaced at distances varying from 6·2 and 12·4 miles apart in Northern Sweden and 0·6 to 3·1 miles apart in Central and Southern Sweden, according to the density of the crop, were found to give an accuracy on the aggregate of within 2 per cent. of the accuracy obtainable by a cent per cent. enumeration. The strips ran right across the different provinces from edge to edge, the direction being as nearly as possible at right angles to the general run of the topographical features of the country, so as to obtain the most representative sampling of the different types of forest.

The average number of persons employed in field work was over 100, and in the office 15 persons during the summer and 20 persons during the winter. Each surveying party consisted of a leader and 8-10 men. The strips were located on good topographical maps and followed by means of a compass, and the parties marched along the strip lines, pitching their camps at a new place each night. The compassman proceeded first, dragging behind him a rope 330 feet long. Two calliper men enumerated and measured all trees of 10 cms. diameter and over within a distance of 5 metres (16½ feet) on either side of the rope and the measurements were recorded by a forest ranger, who was also foreman of the party. A certain previously fixed number of the recorded trees of each species and diameter class were automatically, that is to say without selection, taken out as

sample trees, and were thoroughly investigated by a sample tree taker and his assistant, and all data regarding height, taper, cubic volume, age, diameter and height increment, and defects were recorded on a separate card. The data on these cards was subsequently used for calculating the cubic volume and increment of these and all other recorded trees.

Along the drag rope, the length over areas of productive forest land, arable land, pasture, bog, field, rock, lakes, rivers, gardens roads, etc., was measured by two chain men and recorded by the party leader. The productive forest land was further subdivided and classified according to productivity and different forest types.

Control of the work of the different parties was exercised by the supervisor of the field work who would descend upon an unsuspecting party, and would have the last investigated, two kilometres resurveyed and enumerated again, and compared with the original survey and enumeration figures, to ascertain whether the work was being done with sufficient precision or not.

It is difficult to grasp from mere figures the immense proportions of the work. The parties cruised a total distance of 32,300 miles a distance longer than round the equator, and no less than 1,80,000 sample trees were investigated. The survey was completed in the autumn of 1929, and all the results were worked out and made available in a preliminary report to the King in December, 1929, only three months later,—a remarkable feat with such a small staff.

There is no space here to give full details of the results of the survey, but the following figures are of interest. 56.5% of the total land area of Sweden is classified as productive forest and covers an area of 57. 3 million acres. The average total stand of timber, excluding bark, is 866 cubic feet per acre of which 759 cubic feet are over 4 inches in diameter. The mean diameter over bark at breast height works out at only about 8 inches for pine and about 6 inches for spruce. There is very little timber of 18 inches diameter and over. The rate of volume increment for all coniferous trees averages 3·25 per cent. per annum, and

for broad-leaved trees of 2 inches diameter and upwards 3·90 per cent. per annum, representing a total annual increment of 28 cubic feet per acre of productive forest land. According to present rates of extraction only about two thirds of the maximum productive capacity of the forests is being utilised.

The cost of the survey is estimated at about 77,000 pounds sterling (Rs. 10,30,000), of which 1/3rd was for compilation. The total cost corresponds to 0·18 annas per acre of land, or 0·32 annas per acre of productive forest, a very low cost for such a far reaching and detailed investigation.

For fuller details of the results of the survey reference may be made to the preliminary report published in English entitled "Swedens Forest Resources," and obtainable upon application to Riksskogstaxeringsnamden, Stockholm. A final and detailed report is expected to be published in 1931-32.

FAUNA OF BRITISH INDIA, BIRDS, VOLUME VIII, 2ND EDITION.

By Stuart Baker, 1930.

The author, Mr. E. C. Stuart Baker, is to be congratulated on the completion of this the last of the revised volumes of the Fauna dealing with birds. The revision has undoubtedly been a work of great labour, but the publication of the earlier volumes seems to be already bearing fruit in the steadily increasing interest which is undoubtedly taking place in the study of birds in India. What we now most urgently require are more popular books, well illustrated, and especially such as will appeal to the young. There is perhaps no study more educative and suitable to the young mind than that of bird life, and it is common knowledge that a love of birds once grafted on the young will usually retain its influence through every vicissitude of life. Mr. H. Whistler's recent book is already well known, but there is ample scope for many more like it, and the 2nd edition of the Fauna of British India now completed should form a sure foundation on which the author who wishes to appeal to the amateur

may build. There is little to comment on the last volume now before us. Comprising some 300 pages, it is divided into three fairly equal parts. The first part completes the synonymy of genera, species and subspecies commenced in the previous volume. The second part includes a long list of corrigenda and addenda, whilst a general index to all the eight volumes occupies the concluding portion. The number of names which the author has found it necessary to alter is regrettably large, and all who possess this edition will do well to make the corrections in manuscript in the earlier volumes at once. At the same time references in these earlier volumes should be made to all species and subspecies which have now been added. A. E. O.

HOWARD'S FOREST POCKET BOOK :—HINDI TRANSLATION.

BY P. DHARNI DHAR JOSHI, E.A.C. FORESTS, U.P.

Printed at the Government Press, Allahabad, Cloth Bound, pp. 247, price Re. 1-4-0 (1930).

This is a Hindi translation of Chapters I—III, Section 6 of Chapter V and Sections 4, 12 and 14 of Chapter VII, of the well-known Forest Pocket Book, by Mr. S. H. Howard, I.F.S. Pandit Dharni Dhar Joshi has done a great service to the Hindi-knowing subordinates of the Forest Department and others interested in plantation work to whom the book will be a valuable help and guide. The necessity for close adherence to the English text, and the lack of Hindi equivalents for technical terms and phrases has robbed the translation of the felicity of expression one finds in the original. To make the technical terms clear, a glossary is given in the beginning of the book in which these terms are explained but we do not, however, agree with the definition of Yield Tables as a tabular statement giving the course of development of a tree, instead of a crop. Nor are we sure if the Sanskritised language used in places will be readily intelligible to an average Hindi-knowing Forester, and could not be avoided. In the neatness of print and get up, the book maintains the reputation of the original. I. D. M.

ARITHMETIC OF HOME FORESTRY.

II.—THE ENCOURAGEMENT OF PLANTING BY MEANS OF STATISTICS.

By "Beechwood."

The chief points about economy in forest costings may, perhaps, be here alluded to. First, nursery work. There is no doubt that where seedlings and transplants can be raised at home a considerable saving will be effected. It is possible to produce Scots pine transplants, three years old, for 17s. 6d. per 1,000, against the 27s. 6d. of nurserymen, and larch at 30s., against 45s. The latter may mean a saving of £1 per acre when planting, which at 4 per cent. over 50 years reduces the debt against the crop by £7.

Then fencing is an important item often overlooked when estimates of profit and loss are being made. In this country it is practically always against rabbits, and the cost may be considerable, especially where small plantings are being made. To fence in a 10-acre block will cost about £4 per acre, which will pile up a debt against a 50-year-crop of at least £ 30.

Planting nowadays is rather more carefully done and is costing more than formerly, owing to the greatly increased cost of labour. Economy is being practised regarding the number of plants put in per acre, especially in the case of larch. In pre-war days 4ft. apart was a normal distance, but now 6 ft. is quite usual. It has been found that the trees grow, as a rule, much better, fewer of them die, labour costs are less, and initial costs are much reduced. In 4-foot planting 2,722 trees are required and in 6-foot planting only 1,200. The result is that planting costs are halved, and this compensates for the fewer thinnings and the need for filling up spaces where trees have died.

Nowadays far-seeing owners of forest land are converting their woodland into commercial units, thereby putting them into Schedule D. (profit on business) for taxation purposes and still further lessening their costs. This is an excellent scheme for the present generation and the next, but one of their descendants will have a very large amount of tax to pay at some

time in the future. Newly planted woodlands under Schedule D. can now cut their initial costings to a minimum with the help of the Government planting grant, as follows :—

Cost of establishment...	... ...	£10 per acre.
Less Government grant	... ...	£2
Repayment of income and super-tax at 10s. on £8	...	£4
Net cost	... ...	£4 per acre.

(New woodland naturally shows a loss).

Maintenance charges for looking after the woodland obviously vary. In some cases they are set off against shooting rents, but these have to be high to balance an annual charge of at least 10s. per acre per annum. On most woodland estates the shooting is of definite value, and it would seem that 4s. per acre over and above the shooting value is a fair average at present for maintenance and overhead charges.

Regarding the methods chiefly used in estate foresty for striking a profit and loss account on a woodland crop, the most usual is that which shows the rate of compound interest yielded by the investment when the trees are felled. In this case the lump sum received when the trees are felled is added to the money obtained from thinnings, which has naturally accumulated at compound interest from the time of cutting out until the final felling. From this are deducted the outgoings throughout the period. Example :—

			£
Thinnings at 25 years = £10 at 4% for 45 years	...	=	58
" 35 " " 35 "	...	=	39
" 45 " " 25 "	...	=	26
" 55 " " 15 "	...	=	18
" 65 " " 5 "	...	=	12
Value of final crop, 4,000 c.ft.	...	=	210
			363
Outgoings at 4s. per annum for 70 years @ 4%	...	...	72
			291
Deduct original capital expenditure on planting £8, and add the value of the land £10=	... ...	...	2
Approx. net credit	... ...	...	£300

The original expenditure was £18, being £10 for land and £8 for planting; thus £18 has amounted to £300 in 70 years and £1 to £16 12s. in that period. At 4 per cent. £1 amounts to £15 5s. in 70 years, so that interest is just over 4 per cent.

This may be compared with Example I., where it will be seen that if compound interest is not charged the return is apparently four times as large.

The same result may be obtained by the following rather terrifying formula, which, as a matter of fact, is not really terrifying:

$$\frac{F+Th1+Th2+Th3 - - - - Th6-(C+Re)}{R}$$

F = Value of final crop.

Th = Value of the various thinnings calculated at compound interest until the final crop is cut.

C = Cost of planting.

R = The number of years between planting and felling.

E = The annual expenditure calculated at compound interest.

This formula, used instead of the calculation already given, would work out as follows:

$$\frac{210+58+39+26+18+12-8+72}{70}$$

$$= \frac{363-80}{70} = 4\% \text{ just over.}$$

Another method used is to compare the results of afforestation with the agricultural rent of the same area. This is done by finding out the annual rental that would be obtained were the profit from planting converted into a yearly payment. This yearly payment is equivalent to the annual interest on capital invested in (*a*) planting and (*b*) the value of the land. As this result has to be compared with a land rental it will be necessary to deduct the yearly interest on the cost of planting. In the case of the example already given:

	£
Total amount received for timber	363
Deduct expenditure	72
	291
Less cost of planting	8
Net credit	283

In 70 years £1 per annum amounts to £364 at 4% per annum.

∵ £364 = the accumulated value of £1

And £1 = " " $\frac{1}{364}$

And £283 = " " $\frac{1 \times 283 \times 20}{364}$

$= \frac{5660}{364}$ shillings.

Full rental = 15/9 per acre.

8

In this case the rental for land alone will amount to 9s. 6d. per acre, so that the planting of rough land rented at, say, 7s. 6d. per acre would be definitely profitable.

In the above examples no attempt has been made to encourage forest planting by means of statistics. The figures are merely given as a guide to the methods adopted for finding out whether woodland is being run at a profit or not. The figures are all, however, on practical lines. As to whether or not the profit is satisfactory depends on the producer. Taking all things into consideration, the planter may consider that 4 per cent. is not a satisfactory return for his investment. If he is of that mind, he can replant with some more satisfactory species—or invest in something else.

As a general rule English forestry does not emerge from the maze of forest economics with any great credit; in fact, the position is rather the reverse. Naturally the rate per cent. obtained depends on the final price, and this, again, depends on the market, which in England, except in the case of a few favoured species and sizes, is very local. Railway rates make a great difference and will probably continue to be high until the Government woodlands come into the market.

A new and interesting method by which the profitableness or otherwise of forestry may be discovered has been introduced by W. E. Hiley and published in his latest work on forest economics. This shows the actual cost of production per cubic foot of various species. It is a very different way of expressing profit and loss, but it has the great advantage of being easily understood, and enables the cost of home-grown timber to be compared with that of its competitors abroad. Mr. Hiley shows that on good soils, working at 4 per cent. compound interest, trees of 20 cubic feet can be produced:

Scots pine at 1s. 7$\frac{1}{2}$d.
Larch at 8$\frac{1}{4}$d.
Sitka spruce at 4d.
Douglas fir at 4$\frac{3}{4}$d.
Norway spruce at 7d.
Oak at 3s. 6d.

On poor soils the cost of Scots pine goes up to 4s. 6d. per foot and oak to 12s. 2d., whilst Douglas fir goes to 8d. only. The cost of producing Corsican pine on good soil is given as 8d. per foot.

These figures show fairly conclusively that commercial forestry as a profitable investment can only be carried out on good or fair soils, and that planting on poor land is a waste of time and money. It is unfortunate that Scots pine, which occupies thousands of acres in this country, should show such poor financial results, but it is more than likely that a rise will take place in the future and that a 5 per cent. return will be possible.

There is, however, one great asset of woodland which is ignored by forest economists, which is extremely important and which, therefore, must have some money value, and that is amenity. The following example will

explain this: An estate is carrying timber worth £25,000. With its timber this estate is valued for sale at £1,25,000. If the timber or, say, £20,000 worth of it is sold off, is the estate as a whole worth £1,05,000? We venture to say it is not.

(*Timber Trades Journal*).

THE RYOTS AND THE FORESTS.

REPLY TO GOVERNMENT PROPAGANDA.

BY S. G. WARTY.

The leaflet issued by the Government of Bombay on 'Forest Satyagraha' deserves, I should think, more than a passing notice, and that for two very solid reasons. In the first place, unlike other subjects of complaint such as salt-tax, the forest grievances of the ryot are grievances which it is quite within the competence of the Provincial Government to redress. Therefore, instead of advancing any spacious pleading for the continuance of the present state of things, a wise government which really cared for the ryots' interests would take advantage of the present opportunity and adopt the straightforward course of removing all causes of complaint. Or in the second place it was open to Government to take the ryots into their confidence, and while admitting their grievances advise them generally against the breaking of law, taking care at the same time to point out to them better or an equally effective method of gaining their ends.

Either of these courses of action would have been honourable to Government. But, instead, the leaflet in question gives the impression that Government consider that no such grievances really exist, and that therefore no cause for action on the part of Government arises. Such kind of stuff will only be considered an insult to their intelligence by the ryots of this Presidency who are the actual every-day victims of oppression by the Forest Department. But there are many educated Indians and Europeans also in this country who get no opportunity of seeing the life of the ryot in rural areas adjoining the forests, and it is necessary to point out to them how misleading are the contents of the said leaflet and what exactly is the character of the ryots' grievances in regard to the forests.

THE BESETTING SIN.

In India, natural conditions are such that forests have played from time immemorial an important part in the cultivation of the land. Dependence on the forests has formed an essential feature in the cultivators' economy. When therefore for the first time under British rule, this mutual dependence of forests and cultivation was violently upset, the cultivator felt like the fish out of the pond and his agriculture waned,

Not that the ryot did not or does not recognise the need of conserving the forests. The measures in force before 1878 did not seem to be quite unreasonable. But in that year Government passed the Indian Forest Act than which, considered in its ultimate effect on the peasantry and their cultivation, a more monstrous piece of legislation it is difficult to come across. And further the operation of this Act was so emphatically cruel that when Dr. Voelekar, the renowned British agricultural expert, came to India in 1889 to examine India's agricultural conditions, he was amazed to find that vast areas which were fit for cultivation came to be forcibly included in forest. 'The presence of trees or scrub jungle was considered sufficient justification for notifying as forest, land which was in reality more suited for grazing or cultivation than for the growth of trees.'

Something worse than this also happened. The ryots, previous to the passing of the Act enjoyed rights in the forest established by custom and usage from ancient times, such as free grazing, and free supply of timber and fuel. These rights were all now transformed into mere privileges revocable at the pleasure and discretion of the Forest Department. It was thus that the ryot was left to the tender mercy of the forest official in whose hands the administration of the Act, so far as the ryots are concerned, has been an 'engine of oppression' indeed. And of all the Provincial Governments, the Bombay Government have sinned the most in this respect.

Barbarous Laws.

Even the greatly curtailed privileges that are still allowed to be exercised in the forest, are rendered nugatory in practice because they are hemmed in with untold restrictions. Moreover, for these small mercies, the price exacted from the ryot, measured in sacrifice and in hardship, is unthinkable.

Let me give here only one instance. In return for the privileges allowed, the ryots are required under law to render assistance in extinguishing forest fires. Suppose a forest fire breaks out. The forest official has power to punish, and does punish, all the villagers within an area of ten miles' radius who did not render assistance, whether they were really cognizant of the fire or not, the presumption being always against them.

The punishment usually takes the form of a sudden enhancement of grazing fees to an extraordinary pitch, the fees being levied per head of cattle, so that if a villager has 8 heads of cattle and another 2, the former has to pay four times what the latter does, though the offence of both is equal. I have no space here to describe the nature of this most barbarous law, but the fact that it exists in the 20th century under British rule is a measure of the solicitude of Government for the Indian ryot.

Broken Pledges.

Grazing in forests was absolutely free in India from ancient times and the iniquitous impost of grazing fee was an invention of the Forest Depart-

ment who being incapable of increasing the income from the forests by expert development on legitimate lines, tried to conceal their incompetence, their inefficiency and want of real silvicultural skill, by raising forest revenue from the taxation of the ryots' cattle.

Then again the Government of Bombay had given a definite pledge in their resolution dated September 15, 1909, that the grazing fee shall in future be maintained at the rate of 2 as. but they broke this pledge and enhanced the rate to 4 as. in 1923-24, all round, even without consulting the Legislative Council.

There are many other broken pledges of this character. One more may be mentioned. The Government of Bombay had clearly recognised in a special G. R. in 1868, the right of the occupants in the Thana district to the after-growth of teak trees in occupied Varkhas lands, but in 1883 they suddenly confiscated this right by framing an iniquitous rule under the Bombay Land Revenue Code, and upto the present day even in the face of the clearest recommendations of the impartial bodies appointed by Government, the Bombay Forest Commission of 1885 and the Forest Grievances Enquiry Committee of 1925, *this right is not restored.*

Damage to Crops.

Of the many hardships the ryot suffers from the present methods of forest administration, the damage to crops and cattle from wild animals is one of the worst. The measures adopted by Government hitherto, such as co-operative fencing, have been pronounced by the Royal Agricultural Commission as no more than palliatives, and the Commission was therefore of the opinion that 'the grant of gun licenses on a more liberal scale appears the most effective method of dealing with the damage done to crops and cattle by wild animals'.

But this most effective method is the only method which Government virtually refuse to adopt, showing very clearly the nature of Government's interest in the welfare of the ryot. Mark again, how unfair the forest law is on this question. If a tiger kills a cow or a buffalo on private land, the Forest Department is exempt from any liability to compensate the owner thereof for the loss caused to him; but if the owner whose cattle are killed pursues the beast in the forest with his gun even to a small distance, he commits an offence and is liable to prosecution.

How Truth is Concealed.

The statement in the leaflet published by Government that most of the reasonable grievances have been redressed is altogether misleading. The Forest Grievances Enquiry Committee's report of 1926 was a divided one, the majority report being signed by all the non-official members (numbering five) of the Committee, and the minority report signed by the (Forest) official members who numbered four, of whom *three being co-opted* officials for their particular divisions had no right to sign. Thus the

minority report was practically the dissenting minute of one dissenting member. Government in taking action on the report, practically confined themselves to the recommendations of the minority report of one official member, and now claim that most of the reasonable grievances have been redressed. In other words, in Government's opinion the proposals of all other members of the Committee (all of them non-official members of the Legislative Council in intimate touch with rural conditions) were unreasonable and silly, and the one official member (himself the Chief Conservator of Forests) was the paragon of wisdom and common sense.

AN INEFFICIENT DEPARTMENT.

It is incorrect to state that the ryots do not recognise the value of the forests to the country at large. The ryots' demands are made after making full allowance for the necessity of preserving the forests. The forests of this presidency can be divided into two classes for partical purposes, the high forests which are most remunerative and which in fact bring revenue to the department, and the minor forests which are often far from remunerative. The ryots' demand is for an adequate extent of 'minor forests' in which to exercise his privileges.

It would appear reasonable in the general interest of the country that all the silvicultural skill and knowledge of the Forest Department should be concentrated on the development and exploitation of the high and profitable forests. But the Forest Department have been unable to do much in the matter, owing solely to the incompetence of the Department. Only recently some start has been made. The forest official has thought that his whole duty was to keep on quarrelling with the ryots on the 'minor forests' question, neglecting the more important high forests, as also the development of forest industries. If the high forests were properly developed they should yield double the present revenue therefrom; but, alas, the ryot remains to him the villain of the piece.

AGRICULTURAL COMMISSION'S PROPOSALS.

Such are the forest grievances of the ryot which the Government have failed to redress up to the present moment. The Royal Agricultural Commission after due examination of these grievances, have made very sensible proposals, the most important of which is that an adequate extent of the forest areas should be set apart as agricultural forests and entrusted to the management and control of elected forest panchayats responsible to Government through the Land Revenue Department. It was evident to the Commission as much as it is to us, that under the control of the forest official the privileges were rendered absolutely nugatory in practice. What is of still more importance is that the ryots under the proposed scheme will begin to feel a sense of responsibility about the forests open to the exercise of privileges when these are entrusted to the management and control of forest panchayats elected by them.

Though these recommendations of the Agricultural Commission are before Government for two years now, no action has yet been taken by Government and yet the Government declare that most of the reasonable grievances have been redressed. It will be the height of folly for any section of the public to believe this propaganda carried out by the Government,—a Government which, while quite competent to redress the grievances detailed above, remains inactive, and what is most ridiculous seeks to justify its inaction.

(*Leader.*)

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TEAK AND ITS LIME REQUIREMENTS.

BY M. V. LAURIE, I.F.S.

In the "Indian Forester" for April, 1930, an article was published by Mr. J. D. Hamilton, I.F.S., entitled "Teak Bearing Rocks," in which he introduced the theory, in explanation of the localised distribution of teak in parts of Burma, that a considerable amount of lime in the soil is necessary for the proper development of that species. He supported his theory by a considerable amount of observational evidence, and stated that "......mere traces of lime appear to be of little value. The lime must be assimilable in form and in quantity." In another place he remarked that "I would, however, emphasize the point that mere depth of fine soil without lime does not favour teak, whereas even a shallow soil with lime does."

In the Palakadavu Valley in the Anamalai Hills, Madras, small localised patches of magnificent natural teak occur with large intervening stretches of mixed deciduous forest entirely devoid of teak. This appeared to offer a favourable opportunity to test Mr. Hamilton's theory, and to ascertain whether the distribution was due to any chemical differences in the soil of the teak and non-teak areas. Accordingly two teak areas (A and B), and two areas without any teak (C and D) were selected. All four areas lay within a radius of about two miles, and it can be confidently stated that climatic factors were, to all intents and

purposes, identical for all of them, and can be ruled out of consideration as a possible cause of the localisation of the teak patches. Aspect and drainage can also be discounted, because these patches of teak are found on all aspects and slopes, and sometimes on flat and apparently poorly drained alluvium. The four localities are briefly described as follows :—

Teak patch A.—On the Cochin boundary, south of the Periar River, on a ridge. A patch of magnificent pure teak about $1\frac{1}{4}$ acres in extent. Average height about 120′ (estimated). Nine trees between 15′ and 21′ in girth, sound and with clear boles of over 80′ to the first branch. There were a number of other teak trees of over 10′ girth. The patch is clearly defined, and the surrounding forest contains no teak.

Teak patch B.—On the north side of the Periar River, on flat alluvium. Patch about $4\frac{1}{2}$ acres in extent, consisting of almost pure teak of girths between 9′ and 18′ and clear boles of between 60′ and 80′. Total height about 100′ to 120′ or more. Surrounded by bamboo forest totally devoid of teak.

Locality C.—Bamboo area (*Bambusa arundinacea*) on south side of Periar River, on low ridge. No teak occurs within more than half a mile. Chief tree species present were *Lagerstrœmia lanceolata*, *Terminalia paniculata* and *Stephegyne parvifolia* scattered at considerable distances apart. Height growth 120′ to 130′.

Locality D.—Bamboo area on north of Periar on flat alluvium, completely devoid of teak, with very few trees present. Growth not quite so good as in area C.

The soil was in all cases a deep sandy loam. The top 9″ to 18″ was black in colour and rich in humus, and the sub-soil was a light reddish brown colour, and appeared to be more sandy than the surface soil.

Soil samples were taken at two depths from each of the four localities, 0″ to 6″ (surface soil) and 2′ 0″ to 2′ 6″ (sub-soil), and were sent to the Agricultural College, Coimbatore, for analysis. The percentage of Lime (CaO), Phosphoric acid (P_2O_5), total

Potash (K_2O), and the acidity (pH value by quinhydrone method) of the air-dried samples were determined, and are given below :—

	Teak areas.				Non-teak areas.			
	Locality A.		*Locality B.*		*Locality C.*		*Locality D.*	
	Surface soil.	Deep soil.	Surface soil.	Deep soil.	Surface soil.	Deep soil.	Surface soil.	Deep soil.
	Results expressed on moisture free basis.							
	%	%	%	%	%	%	%	%
Lime (CaO)	0·103	0·130	0·385	0·180	0·286	0·077	0·127	0·100
Total Phosphoric acid (P_2O_5)	0·088	0·070	0·090	0·071	0·141	0·12[illegible]	0·075	0·037
Total Potash (K_2O) ...	0·258	0·366	0·223	0·219	0·241	0·281	0·132	0·260
pH (by quinhydrone method).	4·940	4·990	6·490	5·820	6·580	5·590	5·240	5·310

The averages for teak and non-teak areas with their differences and standard errors worked out from the above figures are given below :—

	Lime.	Phosphoric acid.	Total Potash.	pH value.
	%	%	%	
Average for teak areas with S. E.	0·200±·064	0·080±·005	0·267±·034	5·560±·370
Average for non-teak areas with S. E.	0·148±·047	0·094±·023	0·229±·033	5·680±·309
Difference, (teak areas counted positive)	0·052	0·014	0·038	0·120
Standard error of difference of means	±·079	±·024	±·047	±·482

It will thus be seen that there is absolutely no significant difference between the teak and non-teak soils in respect of the

four factors, lime, phosphoric acid, potash and acidity, even though the sampling showed a surprising degree of uniformity. (For the difference to be significant, the differences between the means would have to be at least twice as great as the standard errors.)

The soils gave a uniformly acidic reaction, and the analysis shows that all the samples were markedly deficient in lime as judged by agricultural standards. Mr. Hamilton's statement that teak definitely requires lime for its proper development appears to be discountenanced. The Palakadavu teak is exceptionally fine both in its size and in its clean un-fluted habit of growth, though it is growing on a slightly acidic soil which is markedly deficient in lime.

These statements might be criticised on two points. Firstly it might be argued that the experimental data were insufficient, and that a repetition of the experiment might give a different result. This is however exceedingly unlikely, since the regularity of the sampling, as shown by the standard errors, indicates a fairly constant composition of the soil throughout the area.

A second criticism that might be made is that the samples were all taken from within three feet of the surface of the soil, and that teak, being a fairly deep rooted species, derives at least some of its nourishment from lower levels, which might contain more lime. The underlying rocks throughout the whole of this part of the Anamalai Hills consist of a plutonic gneiss (Charnockite series) which is stated to be deficient in lime and frequently acidic rather than basic. It would, therefore, be exceedingly unlikely that any increase in lime would be found at greater depths in the soil.

It appears, therefore, that lime, in itself, cannot be regarded as a necessity for good teak growth, and some other soil factor,—possibly a physical rather than a chemical one,—will have to be looked for in order to determine the reason for this localised distribution of teak. It is possible that such a factor may be associated with limestone formations in Burma, but this is not the case in the Palakadavu Valley.

It is incidentally possible that teak will grow just as well on the areas in the Palakadavu Valley which at present contain no teak at all, and that some factor, vegetational or otherwise, has prevented it from becoming established, but if this is so, it is difficult to imagine any plausible explanation of the sharp delimitation of the teak areas. The whole problem is one of great interest from an ecological standpoint and its solution might prove to be of considerable value in its practical application to the silviculture of teak.

GAUJ IN THE HALDWANI SAL (SHOREA ROBUSTA) AREAS.

BY M. D. CHATURVEDI, I.F.S., SILVICULTURIST, U. P.

CONTENTS.

1. INTRODUCTION.

1. Although the damage* done by *gauj* to the sal (*Shorea robusta*) forests in the United Provinces has always been a matter of grave concern to the Forest Department, the ignorance which exists on the subject is truly appalling. No investigation has hitherto been carried out into the nature of the infection causing *gauj*, and hardly any information is available as to the causative organism and its mode of attack.

2. While the detailed study of the fungus causing *gauj* has an important bearing on the control of the disease, it must be remembered that diseases of trees usually cannot be cured. In

* An example of the prevalence of *gauj* was furnished in Chilkia Range (Ramnagar) in 1927-28. The outturn estimate very carefully prepared by the Divisional Forest Officer was 60,000 c. ft. Owing to *gauj* the actual outturn obtained was only 33,750 c. ft.

the absence of accurate mycological details about the life history of the fungus, an attempt has been made, at the instance of Mr. S. H. Howard, to devise prophylactic measures, if possible, based on a study of the source of infection in a tree and of the various primary and contributory factors which predispose it to fungal attack.

2. DESCRIPTION OF GAUJ.

3. The term *gauj* is sometimes loosely applied to almost all kinds of diseases which render a sal tree unfit for sawing. True *gauj* can, however, be easily distinguished by the fact that the affected wood somewhat resembles pale yellow sawdust imbedded in the heartwood. The rotted wood is dry, very light and resembles cork in colour. It yields to pressure and crumbles into spongy fibres which will not bear any strain. The progress of the disintegration is further accelerated by the introduction of water, which is instilled in the rotted wood till the tissues collapse completely. The cellulose contents of the diseased wood, coupled with plenty of moisture, strongly suggest favourable conditions for bacteriological activities in destroying the tissues. It is not unlikely that this is the most fruitful source of the hollowness of sal, which is so often met with in *gauj* affected areas.

4. The infection which seems to be caused by *some* fungus, usually travels downwards towards the roots, the size of the affected core becoming progressively smaller down the stem. A number of cases are also recorded in which the infection travelled upwards from the roots. The structural strength of a tree offers greater resistance against the spread of *gauj* transversely than longitudinally. Thus, the diameter of the diseased core is very much smaller than its length; *gauj* travels faster along the stem than across it.

5. Fructifications of the fungus are rare. Indeed, throughout the whole of my investigation I came across only one tree, which was hollow and practically dead, bearing woody fructifications. Although, *gauj* could be traced in this tree right through the stem, it was extremely difficult to exclude the possibility of a secondary infection resulting in these fructifications.

3. Mode of Research.

6. Two hundred sal trees fairly well distributed over an area* where *gauj* occurs freely were felled and for each tree the following points were noted :—

1. Number of trees.
2. Diameter breast height.
3. Total height.
4. Classification of the tree with reference to,
    - *a.* position in the canopy,
    - *b.* crown form,
    - *c.* stem form.
5. Height above the ground,
    where the *gauj* begins,
    where the *gauj* ends,
    total length of *gauj*.
6. Direction of *gauj*.
7. Appearance of the stem,
    where the *gauj* begins,
    where the *gauj* ends.
8. General appearance of the tree.

Trees affected with *gauj* were split open and the source of infection was traced. In cases of multiple infections the source of every individual infection was traced. All doubtful cases, where a secondary infection such as insect attack had taken place,

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* Description of the Locality.

Situation ...	... E. Jaulasal and Sudlimath Blocks (Haldwani Division).
Elevation ...	... 600 feet approximately.
Aspect and slope	... Slope is variable ; the ground is undulating.
Rainfall ...	... 70 inches approximately.
Type of locality	... The area is cut up into ravines which deepen towards streams. The ground is intersected by *nullahs*.
Drainage ...	... Both horizontal and vertical drainage are fairly effective.
Soil ...	... Variable. Generally the upper layer of 2 to 3 ft. is clayey loam, with a varying mixture of sand, overlying loamy sand of yellowish colour. The upper layer has been rendered dark by humic contents.
Frost ...	... The area being low-lying, compared with the general level of the country, suffers from very sharp frosts.

were carefully described. Attempts were also made to investigate the influence of the factors of environment on the susceptibility of an area to the infection of *gauj*.

4. RECORD OF OBSERVATIONS.

7. It should be noted that these trees were selected at *random* and the percentages worked out below refer to a single sample chosen haphazard. It was found impossible to eliminate the personal factor in the choice of these trees. Of 200 trees examined 57 per cent. were distinctly *gaujy*, 34 per cent. were sound and the rest were hollow and insect attacked. The source of the infection in a large number of cases was traced up the stem to a hump, a swelling giving out epicormic branches, a knot where a branch had existed previously, a forking point, or a frost scar. There was, however, a small percentage of doubtful cases in which it was difficult to associate the source of an infection with something abnormal in the stem. Not infrequently such trees were bent for want of light. The fact that almost all such doubtful cases were confined to biggish trees suggested that the source of initial infection was so completely occluded by the annual growth that the stem assumed quite a normal form in course of time. About 5 per cent. of the affected trees had their source of infection in the root stock and the *gauj* travelled upwards. In the majority of cases (95 per cent.), however, the *gauj* was travelling downwards.

8. Later, 25 indicator plots each (80′ × 60′), about a tenth of an acre each, were selected fairly well distributed all over the area*. Every tree under 9″ d. b. h. was felled in these plots and the following points were noted :—

(*a*) Mean d. b. h.

(*b*) Total number of trees (under 9″) per plot.

(*c*) Height.

(*d*) *Gaujy*, sound, insect attacked, hollow.

(*e*) Direction of *gauj*.

(*f*) Tree class.

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* This investigation was confined to the same locality in which 200 trees were felled at random.

The main object of this investigation was to determine the extent of *gauj* in the saplings which constitute the future crop of these areas. It may be noted that although the choice of these plots involves a personal factor, the individual trees (under 9″ d. b. h.) are free from errors of sampling and can be relied upon to give a better insight into the incidence of *gauj* in young crops than a selection of a few trees at random.

9. An analysis of the results obtained reveals the following :—

Total number of trees under 9″ d. b. h. felled and examined (25 plots)	1,548	
Sound trees	35 %	
Unsound trees	65 %	
a. Gaujy	57 %	60 %
b. Gaujy and insect attacked	2·6%	
c. Other defects, insect attack, etc. ...	5 %	

10. The trees examined varied in height from 4′ to 66′ and in d. b. h. from 1·2″ to 10″*. In the 25 plots examined the proportion of *gaujy* trees varied from 35 to 90 per cent. *Gauj* was found invariably to start from a knot, a swelling, a frost scar, a forking point, an epicormic branch or some abnormality in the form of the stem. In about 70 per cent. of the diseased trees it travelled down the stem. There were some trees (30 per cent.) in which the *gauj* came upwards from the root stock.

5. Factors of Environments.

a. Frost.

11. Of the climatic factors, frost seems to be a fruitful source of infection of *gauj*. Mr. A. E. Osmaston† demonstrated that the rot invariably started from the frost scar at the base of a new leader and spread down the stem. This was

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* As a rule all trees under 9″ d. b. h. were felled. A few trees up to 10″ d. b. h. were also examined.

† Frost as a Cause of Unsoundness in Sal. Ind. For., Oct. 1923, p. 539 *et seq.* Mr. Osmaston examined 55 trees at Gola Tappar (Dehra Dun) and Sitabani (Ramnagar) ranging from 6″ to 12″ in d.b.h. and 50′ to 70′ in height.

later corroborated by Mr. G. M. Hopkins* who felled in the Ramnagar Division 44 trees which were the healthiest in an area and looked perfectly sound (42 of which were dominant). With one solitary exception all these trees were found to be unsound with the rot invariably starting from the frost scar down the stem.

12. The locality in which the investigation has been carried out being low-lying compared with the general level of the country, is peculiarly liable to frosts which occasionally assume extreme severity. Although the effects of frost in this particular case have been minimized to a small extent by the protection afforded to young saplings by overmature trees in the upper canopy, nevertheless, frost is quite an important factor to be reckoned with in this locality; in a large number of cases *gauj* was distinctly traced to frost wounds. Suppression in a crop produces an effect not unlike frost damage and it is not always possible to distinguish the two. In the locality under investigation suppression was as important a contributory factor as frost. The confusion caused by the similarity of effect produced by frost and suppression renders it extremely difficult to determine the exact extent to which a particular factor is operative in making a tree susceptible to *gauj*. The problem is further complicated when the same tree is distinctly affected by both. The infection of *gauj* which could be definitely attributed to frost damage was found as under :—

(*a*) *200 trees.*

Of the *gaujy* trees only 30 per cent. could be ascribed to frost damage.

(*b*) *25 plots.*

Of the total number of trees (1,548) about 60 per cent. were *gaujy*. Only 10 per cent. of the total number of trees examined were forked and had distinct frost damage. Among the frost damaged trees (151):—

50 were sound,
84 were *gaujy*,
17 insect attacked and hollow.

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* Ind, For., May, 1924. p. 243 *et seq.*

The frost damage alone, therefore, cannot explain the incidence of *gauj*.

b. Edaphic Factor.

i.—Configuration of the Ground.

13. The configuration of the ground, beyond generally indicating the susceptibility of an area to frost damage and consequent high proportion of *gaujy* trees, did not account for the incidence of *gauj* in a given plot. The configuration of every single plot was carefully noted, and it was found difficult to correlate the high proportion of *gaujy* trees in a plot with any definite aspect, slope or even depression. As a matter of fact, it was a low-lying plot which had the minimum number of *gaujy* trees.

ii.—Soil.

14. The fact that certain localities are more susceptible to *gauj* than others can be easily explained by their liability to frost and other contributory factors, without bringing the soil into question. The spectacle of perfectly sound trees standing side by side on the same type of soil with those absolutely *gaujy*, eliminates, for all practical purposes, the influence of soil conditions on the susceptibility of an area to *gauj*. Then again, the frequency of *gauj* on areas with all types of soils varying from stiff clay to fresh moist loam, makes it extremely difficult to correlate it with any particular soil. The legend attributing *gaujy* trees to reddish clayey soils seems to have no foundation. It might be added that poorly aerated stiff clayey soils frequently occurring in badly drained depressions, or intensely dry sandy soils are by no means without any adverse influence on the growth of sal crops which they support. Such extreme types of soils inhibit the natural growth of sal trees which, for want of favourable conditions, develop stunted stems and unhealthy crowns with little power of resistance against adverse influences and fall an easy prey to diseases of which *gauj* might quite conceivably be one. Stress may also be laid in this connection on the reputation which some clayey localities have gained for producing the soundest sal.

c.—Treatment (Suppression).

15. The forest, to which the present investigation has been confined, is characterized by an acute suppression which has gone on unchecked in the past. The overwood is mainly composed of sal with an occasional admixture of *asna* (*Terminalia tomentosa*). The area abounds in badly shaped mature trees with unhealthy crowns overtopping saplings which, for want of light, have bent leaders and poor stem forms with unsightly swellings, humps and club-shaped formations. Trees which constitute this extremely irregular crop are full of epicormic branches and on the whole present a sickly look usually associated with primeval uncared-for forests. With the recent removal of the old mature trees, patches of varying size of saplings have come up here and there which show signs of bad treatment accorded to them in the past. The lack of uniformity in this crop and a high degree of stocking has not altogether been an unmixed evil. Overmature trees in the upper canopy have provided a measure of protection to saplings against mild frost. This protection has been, however, uncontrolled in the past and seems to have done more harm than good by suppressing the saplings almost completely.

16. To correlate suppression with the predisposition of trees to *gauj*, every tree which was felled was classified according to its position in the canopy and the form of its crown and stem. The Forestry Commission's tree classification, coupled with Schotte's definition of the canopy classes as modified by Mr. H. G. Champion, was adopted for this purpose. The frequency of distribution of *gaujy* trees over various classes of trees is given below :—

TABLE I.

Tree class.	Percentage of *gaujy* trees. 200 trees.	Percentage of *gaujy* trees. 25 plots.*
Class 1.—Predominant or Dominant trees *D1*.		
(*a*) Trees with normal crown development and good stem form	0	60
(*b*) Trees with slight defective stems or crowns	67	55
(*c*) Trees with very defective stems or crowns	44	70
Class 2.—Co-dominant trees *D2*. (height above 5/6 of *D1*).		
(*a*) Trees with normal crown development and good stem form	37	60
(*b*) Trees with slightly defective stems or crowns	50	60
(*c*) Trees with very defective stems or crowns	57	70
Class 3.—Sub-dominant trees *d*. (height above 2/3 of *D1*).		
(*a*) Trees with normal crown development and good stem form	53	70
(*b*) Trees with defective stems or crowns ...	61	70
(*c*) Trees with very defective stems or crowns	61	80
Class 4†.—Suppressed trees, s. (height about ½ to 2/3 of *D1*.)		
(*a*) Trees with normal crown development and good stem	43	75
(*b*) Trees with defective stems and crowns ...	82	85
†*N.B.*—These are trees standing under the shade of other trees but still capabe of development.		

It will be seen that while sub-dominant and suppressed trees, particularly with defective stem and crown forms, largely suffer from *gauj*, even the predominant trees with good stem form are not free from it. While, therefore, suppression accentuates the

*Includes insect attacked trees.

infection from *gauj* its absence by no means secures immunity against it.

d.—Animal Associates.

17. The damage caused to young saplings by game may also prove a source of *gauj* infection. In the majority of cases, however, the height of the source of infection above ground is such as to exclude the animal factor completely. Only in trees, in which the source of infection is below 10 feet above the ground the possibility of the animal factor being responsible for creating conditions for the attack of *gauj* arises at all. Out of 115 *gaujy* trees* only about 20 per cent. can be at all associated with animal damage, if all the factors which account for the infection of a large percentage (80) of trees (in which the very height of the source of *gauj* excludes the animal factor) are completely disregarded.

e.—Accidents.

18. All accidents like fire, storms and other sources of mechanical injuries would naturally constitute as contributory factors to the infection of *gauj*. The suggestion that wounds caused in cambium layers of trees by hammer marks lead to the spread of *gauj* is rather far fetched considering the height of the source of infection (being usually well beyond the human reach) which generally obtains in sal trees. These contributory factors have significance only when conditions for the spread of *gauj* have already been brought about by primary causes.

6.—CONTROL.

19. It is difficult to devise measures for control in the absence of the details about the life history and the mode of attack of the organism causing *gauj*. Even the healthiest and sound looking dominant trees are not free from *gauj*. The infection *seems* to enter through wounds and the primary causes would appear to be :—

1. Frost
2. Animal associates
3. Accidents like fire, wind-break, etc.,

*From the first investigation based on 200 trees.

all causing an interruption in the bark surrounding a stem and letting the *gauj* in. No control can be exercised over frost (the locality in question is frequented by severe hill frosts which render protection from standards ineffective). Animal associates can be excluded by deer proof fences and damage due to accidental fire can be controlled to a large extent. The edaphic factor and lack of proper silvicultural treatment constitute merely contributory factors. Little can be done to improve soil conditions, while proper early thinnings in these areas can eliminate the suppression which seems to accentuate *gauj*. It will be best not to keep suppressed dead and dying trees in *gauj* affected areas and thus eliminate infection centres.

20. The cutting back of young crops in these areas is attended with great risks and should not be resorted to unless it be on a small scale as an experimental measure. The facts that some of the root stocks are *gauj* infected, and that the hill frosts are frequent in this locality render the possibility of raising healthy coppice crops extremely remote. It is also extremely difficult to tell at sight whether a standing tree is *gaujy* or not and clear-felling may involve the sacrifice of trees which might well constitute the future crop.

PORTABLE CHARCOAL KILNS.

By F. D. Ardagh, I.F.S., Officer-in-Charge, Minor Forest Products Section, F.R.I., Dehra Dun.

As it had been realised for some time that there might be scope in India for portable charcoal kilns, the attention of the Economic Branch of the Forest Research Institute was devoted to a study of the various types of portable kilns on the market. The claim advanced in the case of some of these kilns is that they are readily portable, are simple to operate (in some cases automatic) and are not restricted in use by rain or lack of water.

As the result of a preliminary review of the whole situation, the Forest Research Institute decided to purchase two kilns of French manufacture, which appeared to be most suitable for the conditions prevailing in India, and to submit them to practical tests. These two kilns were received towards the end of 1928

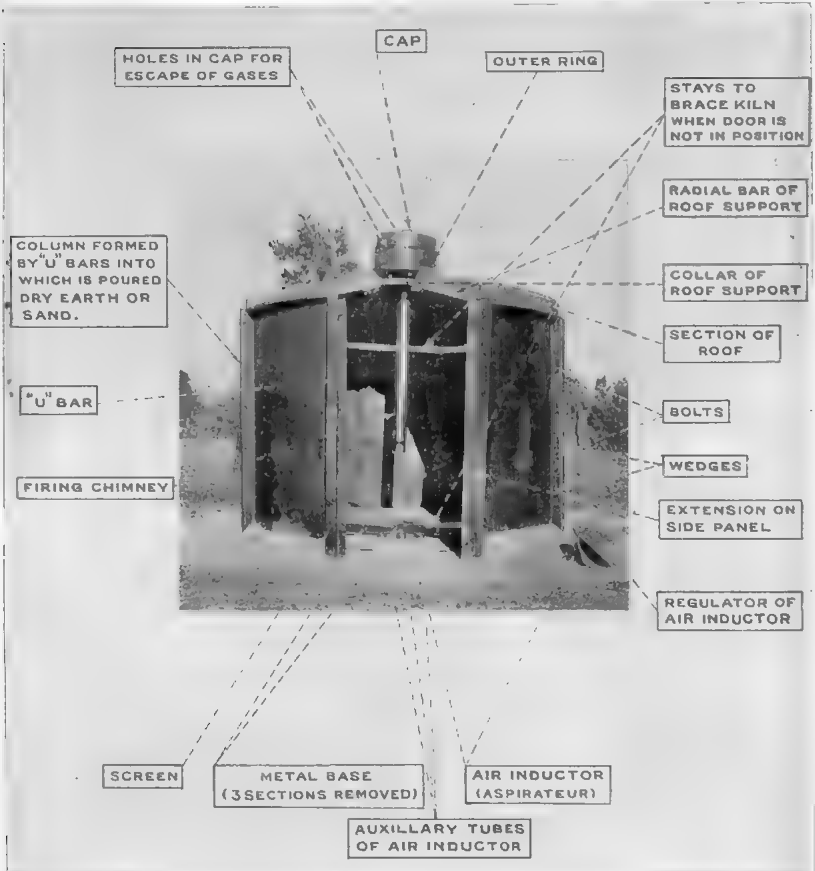
and, though the experiments are far from complete, it may interest readers to learn the results of experience with these kilns and the conclusions that have been arrived at to-date.

The "Trihan" kiln, which is illustrated in the accompanying photograph, was purchased from Messrs. M. Trihan, Vernon, France, but Messrs. Alfred Tattersall & Co., 75, Mark Lane, London, E. C. 3, have now entered into an agreement with this firm for the marketing of these kilns throughout the British Empire. The kiln is of the "Vertical Automatic" type with a capacity of 250 cubic feet. It is circular and is composed of 8 curved steel panels, 5′ 5″ in height and 2′ 8″ broad. These panels are joined together by "U" bars, or channels, and by bolts and wedges. These "U" bars, together with the extension of one panel, form a hollow column into which dry earth or sand is poured to form an air-tight joint. The roof is composed of 4 sections, resting on a collar supported by 4 radial supports, which hook into 4 of the panels. Provision is made for an earth joint between each of these sections to render them air-tight. In addition, there is a metal base composed of 8 sections, the point of each fitting over one of the auxillary tubes of the air inductor which is buried in the ground below. Eight screens are provided to prevent the glowing charcoal from coming into contact with the base of the panel and so causing buckling.

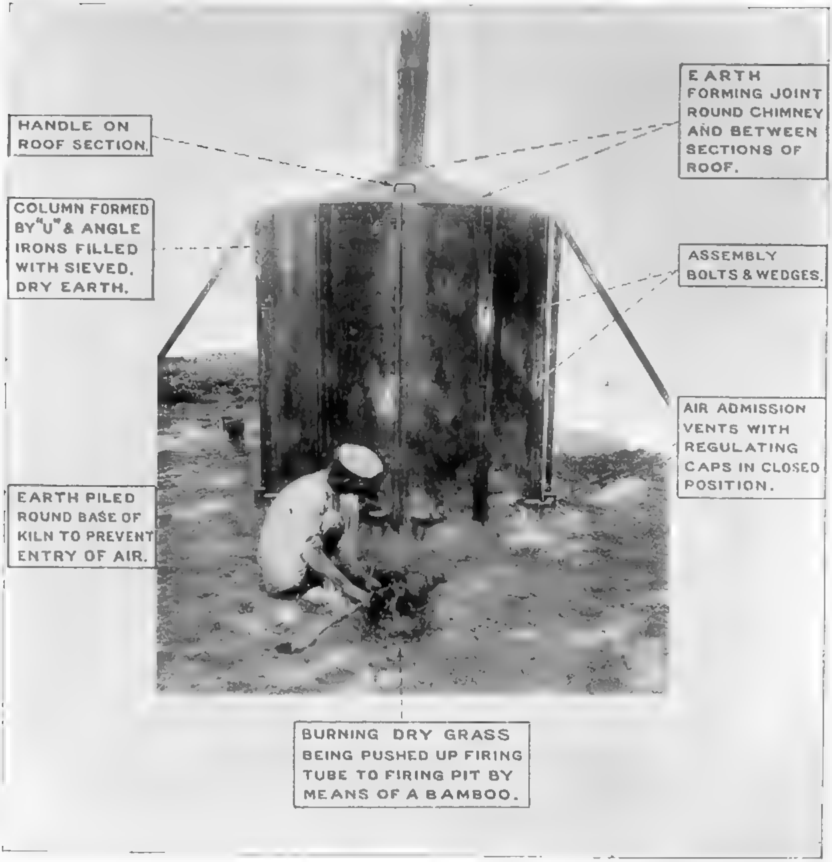
Experience has shown that this kiln can be erected quite easily by two coolies, who, with a little experience, should be able to prepare the site and erect the kiln in about 1½ hours. Loading with billets ready cut, prepared and stacked near the kiln takes about 2½ hours, while sieving of the earth and formation of the earth joints takes about 1 hour and lighting a matter of ½ hour. The time taken for the kiln to burn depends very much on the species used and on the moisture content of the wood, an average being about 50 hours (maximum noted 90 hours, minimum 28 hours). Cooling takes from 10 to 12 hours depending on the temperature of the outside air, provided that the kiln has been made really air-tight when closed down.

The second kiln known as "La Bastia", was manufactured by André Colson, Revigny-sur-Ornain, France. This kiln is

COMPOSITE PHOTOGRAPH OF "TRIHAN" KILN SHOWING COMPONENT PARTS.



"LA BASTIA" KILN SHOWING METHOD OF LIGHTING



composed of 12 curved steel panels, 6′ 7½″ in height and 1′ 7″ broad with a capacity of about 194 cubic feet. Six of these panels are fitted with angle irons at the sides, and 6 with "U" irons (channels) and are assembled alternately so that vertical columns are formed by the junction of the panels into which sieved dry earth or sand is poured to form an air-tight joint. The panels are joined together by bolts and wedges. The roof consists of 4 sections resting on two diametral supports, which hook into holes on the upper ends of the panels. In addition, the kiln is provided with a chimney composed of sections which fit one into the other. Each panel has at its base an opening for the admission of air, over which is fitted a cap to regulate the amount admitted. When small sized material is being carbonised, air boxes are provided to reduce the amount of air that can be admitted, each box fitting over the air holes at the base of two adjacent panels. Each panel is also provided with an inspection port which is closed by an iron plug.

Two coolies can erect this kiln quite easily and with experience should be able to prepare the site and erect the kiln in about 1½ hours, provided that the soil is not stony or difficult to work. The laying of the firing tube, preparation of the firing pit, and building up of the cone of readily inflammable material takes about ½ hour, charging the kiln with material, cut and stacked ready to hand, takes from 2 to 3 hours, while fixing of the roof sections and making good earth joints takes a further ½ to ¾ of an hour. The total time taken from the arrival of the kiln at a new site till it is actually under way and burning is, therefore, in the region of 5 to 6 hours, provided that the wood is ready cut and stacked near the site on which the kiln is to be erected.

The average time taken for the kiln to burn is 45 hours, depending on the nature and moisture content of the material with which it has been charged. The kiln cools in about 8 to 10 hours, but the time taken depends very much on the temperature of the air.

Unfortunately very little work can be done at the Forest Research Institute itself owing to lack of suitable material, while

carting to the Institute of material for this purpose is out of the question owing to cost. Work with these kilns has, therefore, been restricted to the cold weather when, thanks to the courtesy of the Divisional Forest Officers, it has proved possible to work the kilns in some of the coupes in the Dehra Dun Division. Even so, it is not always easy to find a coupe which not only contains suitable material but is at the same time situated close to a road so that the work can be supervised by the Officer-in-charge. Work in the cold weather of 1929 was further limited by the fact that the kilns were taken on tour for demonstration purposes to Central and South India.

In spite of these drawbacks, a certain amount of experience has been gained in the operation of the kilns and, though the experiments are far from complete, it has been possible to arrive at the following conclusions :—

A. Advantages of portable kilns.

1.—*No water is required for their operation.*

Since no water is necessary for the operation of these kilns, they offer possibilities in localities where local charcoal burners rely on the presence of water for the manufacture of charcoal, and where charcoal burning has perforce to be restricted to areas and to seasons at which water is available. In some localities, wood to be made into charcoal has to be carted to a spot near water, as is the case in certain coupes in the Hoshangabad Division of the Central Provinces. The use of portable kilns would render this carting unnecessary, as the kilns could be moved from place to place in the coupe as required, thereby reducing the cost of cartage and consequently the cost of the charcoal.

2.—*Simplicity of operation.*

Portable kilns are comparatively simple to operate and they can be worked by a coolie of average intelligence, with very little training. They are automatic or semi-automatic in operation, and do not, therefore, require to be watched at night, and 3 coolies could easily look after a battery of 4 to 5 kilns (the makers of the "Trihan" claim that 2 men can look after a battery of 6 kilns of the size referred to in this note), provided that the wood to be

carbonised is close at hand. This fact would reduce the cost of manufacture considerably.

3.—*Increased yield and production of charcoal of high quality.*

In the Appendix will be found a tabular statement of the outturn obtained from several kiln charges, and, for purposes of comparison, the outturn of charcoal in each case has been calculated as having been derived from oven dry wood. This method of calculation is merely to facilitate comparison on a uniform basis.

Under run No. 17 on page 403 of the Appendix figures are given for the outturn obtained from "country" kilns in Hoshangabad Division in the Central Provinces. It is, however, difficult to compare the outturn of the portable kilns with that of country kilns, unless the material used in each case is similar. In the cases for which figures have been given, the portable kilns were not available, so that the actual figures of outturn from similar material could not be obtained for purposes of comparison, but the material used in the last two instances (for which figures are given in the Appendix) was very similar to that used in run No. 16 with the "Trihan" kiln. In the latter case an outturn of 26·4 per cent. was obtained, as compared with an outturn of 17·0 per cent. and 22·7 per cent. for the "country" kilns.

It may, however, be assumed with safety that the outturn obtained from the portable kilns is higher than that obtained from "country" kilns, and there is no doubt that the charcoal produced by the former is of higher quality than that produced by the latter. In confirmation of this statement it may be noted that the calorific value has been determined for the charcoal of several species produced by the two methods. In every case the values for the charcoal produced by the portable kilns were slightly higher than those for the charcoal produced by "country" kilns.

4.—*Elimination of danger from fire.*

The manufacture of charcoal with portable kilns is not attended with risks of fire, as is the case with "country" kilns. This enables the manufacture of charcoal to proceed with safety in

the hot weather long after manufacture by ordinary methods has had to cease owing to fire hazard.

5.—Production of charcoal unaffected by heavy rain.

Experiments were conducted to determine whether these kilns are in any way affected by heavy rain, and the results obtained were most satisfactory, proving conclusively that these kilns are not affected by heavy rain and that the manufacture of charcoal could be carried out when other forest work has had to cease on this account.

B.—DISADVANTAGES OF PORTABLE KILNS.

1.—High initial cost.

The most adverse feature of these kilns is the large capital expenditure necessary for the purchase of a battery of kilns. The latest quotation for the "Trihan", recently received from Messrs. Tattersall & Co., is £81 c. i. f. Bombay, while the "La Bastia" costs about £40.

2.—Weight and size of the component parts.

The component parts are somewhat heavy and bulky for transport by coolies over long distances, as would be necessary in the hills, where roads are non existent. A panel (with extension) of the "Trihan" kiln measures 5′ 5″ by 2′ 8″ and weighs 140 lb., while the heavier of the two types of panel of the "La Bastia" kiln measures 6′ 7½″ by 1′ 7″ and weighs 91 lb. Neither of these panels would constitute a suitable coolie load in the hills, though it would be possible to sling them on a pole for two coolies to carry. They could probably be transported by mules, where mule tracts exist, though no experiments have been conducted on these lines. They are, however, easily transportable in country carts, and are quite suitable on that score for use where carts can be taken.

3.—Limit of size of material that can be carbonised.

To obtain satisfactory results with these kilns it is necessary to cut the billets to a uniform length of 2½′ to 3′ whereas longer material is used in most paraboloidal kilns, no steps being taken to cut the billets to the same length. The use of these

portable kilns, therefore, entails some additional cost in the conversion of the material used. Further, billets of very large diameter cannot be used in the kiln, though further experiments are necessary to deter mine the limit of size that will give satisfactory results. Billets upto 14 inches in diameter have, however, been carbonised quite successfully, when placed in the uppermost layer and towards the centre of the kilns.

COMPARISON OF THE TWO KILNS.

As the result of the work carried out to-date, preference must be given to the "Trihan" kiln. Not only is it more solidly constructed than the "La Bastia," but it also gives a higher outturn of charcoal. Further, it has an added advantage in that it requires no attention whatsoever during burning, while a certain amount of attention is required in the case of the "La Bastia" when carbonisation is nearly complete and burning is taking place round the base, just prior to closing down for cooling. The provision of screens to prevent the glowing charcoal from coming into contact with the lower part of the panels has prevented buckling of the outer plates, while the lower panels of the "La Bastia" have buckled quite considerably. The greatest disadvantage of the "Trihan" kiln is its high price.

It will be noticed that no attempt has been made to draw a comparison between the cost of manufacturing charcoal with these kilns and with ordinary "country" kilns. For any really reliable comparison to be made, a battery of kilns of each type would be required, which would have to be set up and worked alongside ordinary "country" kilns making use of identical material. Such a test is out of the question as a battery of kilns is not available. Some idea of the comparative costs could possibly be obtained by working one kiln alone against a "country" kiln and by taking into consideration the hours of work of the persons engaged in the two operations, but no such opportunity has occurred as yet. In our opinion, however, this comparison is not very essential as these kilns will probably find their venue in localities where manufacture by ordinary "country" methods is rendered impossible from lack of water, lack of professional burners, heavy rain, fire hazard or some such contributory factor.

It is proposed to continue the experiments with these kilns to gain further experience in their working and to gain experience as to their probable life.

As the result of the experience gained, an attempt has been made to design a reliable, but at the same time, simple kiln, the component parts of which will be neither too bulky nor too heavy to form a suitable coolie load, and which can be manufactured in India comparatively cheaply. The design of a kiln of this type presents several difficulties, but it is hoped that these will be overcome eventually and that such a kiln modified to suit the peculiar conditions of India will be evolved. The first kiln designed to meet the above conditions has already been constructed in the Forest Research Institute workshops and it is hoped that it will be thoroughly tested during the next few months. *It is anticipated that it should prove possible to manufacture* a kiln of this type (with a capacity of 275 c. ft. as compared with the 250 c. ft. of the "Trihan") for round and about Rs. 500, and estimates will be called for as soon as a really satisfactory kiln has been evolved.

APPENDIX I.

Results of experiments with "La Bastia" Kiln.

No. of run.	Locality.	Material carbonised.	Weight of wood in lbs.	Weight of charcoal in lbs.	Percentage out-turn.	REMARKS.
1	F. R. I., Dehra Dun.	Small pieces of saw-mill waste of mixed species.	3,554	867	24·4%	
2	Do. ...	Ditto ...	2,417	630	26·6%	
3	Do. ...	Ditto ...	2,829	393	13·9%	
4	Do. ...	Ditto ...	2,857	726	25·4%	
5	Lachiwala, Dehra Dun.	*Adina cordifolia* ...	2,009	480	23·9%	
6	Do. ...	Ditto ...	1,499	462	30·8%	

No. of run.	Locality.	Material carbonised.	Weight of wood in lbs.	Weight of charcoal in lbs.	Percentage out-turn.	REMARKS.
7	Lachiwala, Dehra Dun	*Terminalia belerica, Mallotus philippinensis,* and *Grewia tiliaefolia.*	2,313	580	25·0%	
8	Do ...	*Terminalia belerica, Mallotus philippinensis, Grewia tiliaefolia* and *Ehretia laevis.*	2,295	650	28·3%	
9	Do. ...	*Mallotus philippinensis, Ehretia laevis, Kydia calycina* and *Lagerstroemia parviflora.*	2,603	688	26·4%	
10	Do. ...	*Ehretia laevis, Mallotus philippinensis, Grewia tiliaefolia, Kydia calycina* and *Lagerstroemia parviflora.*	2,418	550	22·7%	
11	F. R. I., Dehra Dun.	Small pieces of sawmill waste of mixed species.	3,707	754	20·4%	
12	Chakrata, U. P.	*Quercus dilatata* and *semecarpifolia.*	3,475	1,010	29·1%	
13	Do. ...	Ditto ...	3,276	886	27·0%	
14	F. R. I., Dehra Dun.	Small pieces of sawmill waste of mixed species.	2,223	747	33·6%	
15	Mysore Iron Works, Bhadravati.	*Terminalia tomentosa, Anogeissus latifolia. Adina cordifolia* and other species.	4,308	806	18·7%	
16	Do. ...	*Anogeissus latifolia* ...	4,726	1,260	26·7%	
17	Do. ...	Ditto ...	5,184	1,540	29·7%	
*18	Do. ...	Ditto ...	5,460	1,344	24·6%	
19	Do. ...	Ditto ...	6,272	1,316	21·0%	Actual figures of outturn. Moisture content of wood not noted.
20	Do. ...	Ditto ...	5,824	1,344	23·1%	
21	Do. ...	*Terminalia tomentosa*	4,259	1,008	23·7%	
22	Do. ...	Miscellaneous ...	3,958	868	21·9%	
23	Do. ...	*Terminalia tomentosa*	4,065	1,176	28·9%	
24	Do. ...	Miscellaneous ...	4,049	812	20·1%	

No. of run.	Locality.	Material carbonised.	Weight of wood in lbs.	Weight of charcoal in lbs.	Percentage outturn.	REMARKS.
25	Mysore Iron Works, Bhadravati.	Miscellaneous heavy billets used for making pit charcoal.	5,646	896	15·9%	
26	Do. ...	Ditto ...	3,733	560	15·0%	
27	Do. ...	Ditto ...	5,376	868	16·1%	Actual outturn. Moisture content of wood not noted.
28	Do. ...	Ditto ...	3,797	448	11·8%	
29	Do. ...	Miscellaneous ...	3,906	784	20·1%	
30	Do. ...	*Anogeissus latifolia* ...	4,582	840	18·3%	
31	Do. ...	Ditto ...	4,416	1,008	22·8%	
32	Do. ...	Lantana	877	168	19·2%	
33	Do. ...	Lantana (pressed) ...	896	280	31·3%	

**Note.*—Figures for run Nos. 18 to 33 were supplied by the Manager, Mysore Iron Works, Bhadravati, Mysore, by whom the experiments were actually conducted.

APPENDIX II.

Results of experiments with "Trihan" Kiln.

No. of run.	Locality.	Material carbonised.	Weight of wood in lbs.	Weight of charcoal in lbs.	Percentage outturn.	REMARKS.
1	Lachiwala, Dehra Dun.	*Terminalia tomentosa, Shorea robusta, Odina Wodier, Lagerstroemia parviflora.*	2,257	772	34·2%	
2	Do. ...	Mixed	2,731	755	27·6%	
3	Do. ...	*Mallotus philippinensis, Kydia calycina, Terminalia belerica,* and *Ehretia laevis.*	2,777	788	28·4%	
4	Do. ...	Ditto ...	2,404	761	31·7%	
5	Do. ...	Ditto ...	3,145	779	24·8%	
6	Do. ...	Ditto ...	3,430	904	26·4%	
7	Do. ..	Ditto ...	2,873	898	31·2%	

No. of run	Locality.	Material carbonised.	Weight of wood in lbs.	Weight of charcoal in lbs.	Percentage outturn.	REMARKS.
8	F. R. I., Dehra Dun.	Small pieces of sawmill waste of mixed species.	4,368	1,313	30·1%	
9	Gorakhpur Tea Estate, Dehra Dun.	*Terminalia tomentosa, Albizzia procera, Dalbergia Sissoo, Grevillia robusta.*	2,898	1,073	37.0%	
10	Do. ...	*Dalbergia Sissoo, Cedrela Toona, Grevillia robusta.*	3,418	1,107	32·4%	
11	Chakrata, U. P.	*Quercus incana* and *Quercus semecarpifolia.*	3,577	1,002	28·0%	
12	Chakrata, U. P.	*Quercus semecarpifolia, Quercus dilatata.*	3,972	875	22·0%	
13	F. R. I., Dehra Dun.	Small pieces of sawmill waste of mixed species.	4,132	911	22·0%	
14	Kodura, Cuddapah South, Madras.	*Eugenia alternifolia* and *Pterocarpus santalinus.*	5,081	1,075	21·2%	
	Do. ...	*Eugenia alternifolia* ...	*2,627*	*515*	*19·6%*	These figures were obtained with an ordinary "country kiln" and are given for purposes of comparison.
15	Dronachellam West Kurnool, Madras.	*Hardwickia binata* ...	4,902	1,750	35·7%	
	Do. ...	Ditto ...	2,650	883	33·3%	
16	Ghoradongri Betul, C. P.	*Terminalia tomentosa, Adina cordifolia, Acacia* spp.	4,381	1,159	26·4%	
17	Bagra, Hoshangabad Division, C. P.	*Terminalia tomentosa*	4,190	1,457	34·8%	
	Hoshangabad Division, C. P.	*Mixed species* ...	*15,231*	*2,594*	*17·0%*	Figures obtained with ordinary "country kiln" which are given for purposes of comparison.
	Do. ...	*Ditto* ...	*14,360*	*3,255*	*22·7%*	

Note.—For purposes of comparison the weight of wood used, charcoal obtained, and percentage have all been given on an oven dry basis.

ATHLETIC SPORTS AT THE FOREST COLLEGE, DEHRA DUN.

BY D. DAVIS, I.F.S.

The annual College Sports were held at Chandbagh on the afternoon of April 2nd, 1931. The Inspector-General of Forests, Mr. Blascheck, and the Gazetted Officers of the College were at home to the students and their friends and to the Officers of the Forest Research Institute who lecture to the students, and between 150 and 200 guests were present to see a very successful meeting.

The first event, the 100 yards, was run punctually at 3-30 P.M., the heat at this hour of the afternoon being too much for most of the guests, who did not arrive in any numbers till after

4 P. M., by which time the Long Jump and Hurdles had also taken place. The first event after this was the 220 yards Junior Staff Race, open to chaprasis, etc., of the Research Institute and College, and the best part of this event was unfortunately missed by all except the starter, who had to prevent one keen competitor from running in an all but nude state! The next race, the quarter mile, was won by Junior Ranger student N. C. Mukerjee from Assam, who had already won the first 3 events, as well as "putting the weight" on the previous day. Mukerjee had thus won 5 out of the 10 events which count towards the Championship, and it was already fairly certain that the Cup was his, as he had obtained 25 points out of a possible 35, and the next competitor below him, Senior Ranger student P. M. Pooviah, had only got 15, having won the half mile and "throwing the cricket ball" before Sports Day, and been 2nd in the quarter mile, and 3rd in the 100 yards and long jump. Subsequently Mukerjee was 2nd in the High Jump, and Pooviah was not placed in any of the last 3 events. So Mukerjee won the Championship Cup easily, and was the outstanding athlete of the day. It was unfortunate that the 7 I. F. S. students only arrived back from camp a day or two before the Sports, and so had practically no opportunity of training. It was thus very creditable for 3 of them to get places, P. A. Menon winning the high jump, and being 2nd in the 100 yards, A. H. Khan being 2nd in the long jump, and Anwary 3rd in putting the weight.

It was perhaps bad luck on Pooviah, the winner of the Marathon Race held on September 27th, 1930, that this race could not count towards the Championship Cup, but many of the runners left the College in October, and many of the present students, including Mukerjee, were not in residence then.

The 2 team races, the sack scrimmage and the tug of war, created considerable interest and amusement and the obstacle race as usual caused considerably more amusement to the spectators than to the already very weary competitors. Two innovations were a children's race and spar-fighting. The children were handicapped by size, and the race proved a close one, the 1st and

2nd prizes going to a brother and sister, Mr. Shah Nawaz Khan's children. Spar fighting produced some keen and amusing battles fought to a finish astride a pole over a tank full of water—the finish being a ducking, this "denouement" being probably far from unwelcome after the strenuous events of the afternoon.

The sun had now set, and by the time the prize winners had made themselves presentable it was getting distinctly dark. The Principal, Mr. A. E. Osmaston, made a short speech congratulating the winners, and thanking those who had been responsible for the success of the day, and finally in the gathering gloaming the Inspector-General presented the prizes which were won by the following :—

100 yards ...	N. C. Mukerjee ...	11 secs.
$\frac{1}{4}$ mile ...	Do. ...	59 secs.
$\frac{1}{2}$ mile ...	P. M. Pooviah ...	2 mins. 21$\frac{1}{2}$ secs.
Mile ..	Md. Sultan ...	5 mins. 32$\frac{1}{5}$ secs.
120 yds.—high hurdles	N. C. Mukerjee ...	20 secs.
High Jump ...	P. A. Menon ...	4ft. 9$\frac{1}{2}$in.
Long Jump ...	N. C. Mukerjee ...	18ft.
Putting the weight ...	Do. ...	25ft. 6in.
Throwing the Cricket Ball.	P. M. Pooviah ...	78 yds. 1 ft. 7$\frac{1}{2}$ in.
Obstacle Race ...	Md. Afzal ...	
Championship Cup ...	N. C. Mukerjee ...	27 points.
Spar fighting ...	Md. Sultan ...	
Junior Staff Race 220 yds.	Bisheshar Datt ...	28 secs.

LANTANA AND COWDUNG PROBLEM.

By R. N. De, I.F.S.

Messrs. Chaturvedi, Mobbs and Hakimuddin, three U. P. Forest Officers have written interesting articles in the "Indian Forester" with suggestions for the solution of the above problem. Mr. Mobbs' article was a critical examination of Mr. Chaturvedi's suggestions which he considers to be impracticable. In the

March (1931) number of the "Indian Forester," a note has appeared, apparently an extract from the "Indian Engineering," in which a writer criticises Mr. Hakimuddin's suggestions regarding the introduction of lantana and comes to the conclusion that other means of providing fuel should be found, as it may be a positive pest. He then goes on to give examples of how foreign importations into a country have flourished so abundantly as to become a nuisance.

In Assam, we have large scale *jhumming* practised by the Hill tribes which, of course, erodes the soil to a certain extent in the 1st year, but owing to heavy rainfall in these parts, vegetation appears very quickly, soon after the burning, with the result that erosion has no very serious effect on the soil. But we have sometimes disastrous floods in the plains when there is very heavy rainfall in the hills, owing to quick drain off of surface water in *jhummed* areas. The country being fairly well wooded, we have no cowdung problem except in some parts of the plain districts where also home grown bamboos, etc., satisfy the want for fuel.

But here we have to deal with a pest, *Eupatorium*, which during the last 20 years has spread all over Assam. No clearing whether it is for *jhumming* or otherwise, is safe from its inroad, if left alone. During the war, I heard it being described by jungle people as 'German ban' *i.e.*, a weed sent by the Germans which is irrepressible. Yet this pest has its uses. In soils exhausted by exposure or otherwise, where many attempts to grow anything have failed, *Eupatorium* has usurped the soil with the greatest of ease. It is a good green manure. It reminds me of another pest—a water weed in Assam—which had also acquired menacing proportions lately. I refer to the water hyacinth. Many rivers, streams and channels were absolutely blocked and allowed no navigation at all. Yet last year, when Surma valley was overrun by a disastrous flood, this pest saved the lives of hundreds of cattle in the form of a fodder.

Nobody ever denies that lantana is a pest *in places* as also mongoose, rabbit or cosmos referred to by the writer in the article under reference. But to draw the conclusion that a pest

s a nuisance *everywhere* is not correct, as will be seen from the examples quoted above.

I consider that Mr. Hakimuddin's remedy, *i.e.*, the introduction of lantana in waste lands, is absolutely sound. Any one who has seen some of the country in the United Provinces that is being eroded every year cannot but think that something must be done. Various suggestions have, of course, been made, but most of them are costly, some are impracticable. Mr. Hakimuddin's suggestion is not at all troublesome and the least expensive. Lands that produce nothing now will not fare worse any way by lantana. Once it has started growing, the erosion will be checked, soil will retain more moisture, while constant coppicing will supply fuel which will replace cowdung for burning. Lantana is not a new importation into this country. From the Nilgiris to the Himalayas it is found and in some places it is positive pest.

Yet, I am not aware that any serious cultural operations in plantations or fields have been abandoned simply because all efforts at its eradication were baffled. Granted that it may spread from the waste into cultivated lands it can be put to good use, *e.g.*, green manure, by the cultivator, as in the case of our pest *Eupatorium*.

My object in writing the above is that although large scale afforestation is being done in Etawah and other places by the United Provinces Forest Department, in view of the dangerous soil erosion that is going on in some districts in the United Provinces, lantana is well worth trying in wastes subject to erosion, to solve the fuel problem and save the cowdung for manuring the fields, in addition to prevention of soil denudation.

THE FLORA OF WEST TROPICAL AFRICA.

BY J. HUTCHINSON AND J. M. DALZIEL.

(*Published by the Crown Agents for the Colonies, 4, Millbank, Westminster, London S. W. 1. Price 8s. 6d.*]

The part now issued is Vol. II, part I, and deals with the families *Ericaceae* to *Labiatae* arranged according to Hutchinson's sequence. This part is uniform with the previous parts and is copiously illustrated with excellent line drawings. The only criticism we have to offer is that there is nothing to show the scale of the figures. Some are presumably natural size, many greatly enlarged, and some reduced. The whole pages used for illustrations usually depict one plant only and as only a limited number of plants can be illustrated the space could perhaps have been better used by increasing the number of plants drawn and reducing the scale of the figures.

TIGER DAYS.

BY HON'BLE JAMES W. BEST, O.B.E.,

(I. F. S. retired). Price 7s. 6d.

(John Murray, Albermarle Street, London, W.)

Whereas the author's previous little book "Indian Shikar Notes" was essentially one of instruction for the would-be 'shikari,' "Tiger Days" comprises some 15 short stories of actual experiences taken from his life as a forest officer, and leaves it to the reader himself to draw from each such lessons as he may. The Chapter on obstinate tigers is particularly interesting.

Although tiger shooting—as may be expected from the title —is the main theme of the book, it has not been overdone and is cleverly interspersed with very true-to-life and amusing accounts of little happenings and types of people with which the daily round of the average forest officer in India is associated. Places and circumstances are also both artistically and vividly described.

The whole is written in a pleasing and easy style, and is illustrated with several photos and pencil sketches by the author's wife.

CORRESPONDENCE.

NOTICE.—Correspondents who wish their letters to appear in a particular number of the *Indian Forester* should ensure that they reach the Honorary Editor by the 15th of the previous month with a request to that effect.

VOLUME LVII.] [NUMBER 9.

INDIAN FORESTER.

SEPTEMBER 1931.

SKI-ING IN THE HIMALAYAN FORESTS.

BY CAPTAIN W. B. BAKEWELL.

In addition to the shooting that a Forest Officer can avail himself of in the coniferous forests of the Himalayas, there is one sport in the winter, which many do not avail themselves of, and that is ski-ing. With a good fall of snow, anyone who has done any ski-ing will own that there is no better sport or form of exercise. Furthermore, Forest Officers will find ski-ing a great advantage when treking in snow, as it relieves the monotony, enabling them to cover distances quicker, and with less fatigue, once they have had a few days' practice. It should perhaps be made clear that getting up-hill on skis presents no difficulties. When climbing, strips of sealskin are strapped on to the undersides of the ski, and the hairs of the skin run into the snow and prevent back slip. It is also possible to climb without skins with the aid of climbing wax, but the beginner is not advised to attempt this, as climbing wax wants some understanding.

Canadian snowshoes, which should not be too broad will also be found a great help, but coolies are obstinate about using them at first, but once they get the hang of them realize their utility.

Ski-ing is difficult in deodar forests on account of the undergrowth and in Kashmir the prolific *pohu* (*Parrotia Jacquemontiana*)

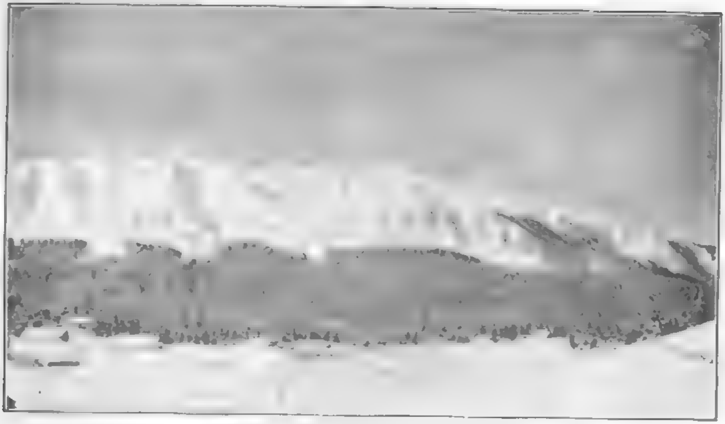
renders many a good run impossible, but in areas worked out under the Shelterwood system, where *pohu* has been cut back some excellent sport can be obtained.

In fir and spruce forests, due to the heavier snowfall and scanty undergrowth, one finds the best ski ground of all, and many enthusiasts prefer running in the forests than on open slopes, where changes in the snow occur more slowly, being protected from both sun and frost.

The ash (*Fraxinus floribunda*) has so far been found to be the best timber for ski and many pairs have been made in Kashmir, but few Indian timbers possess the properties of hickory and ash from which imported ski are made. Toughness, flexibility, even grain, straight fibre and hardness are essential properties, which appear to be generally deficient in Indian timbers. Those Indian species, which possess such properties, have the defect of interlocking fibre, which makes them difficult to bend to the curvature required, as such timber cannot be rent and must be converted by sawing.

Mr. H. E. Kinns, Wood Technologist to the United Provinces Government, and Major Dyce, Honorary Secretary of the Ski Club of India, carried out some preliminary experiments in Rawalpindi on two timbers—*shisham* (*Dalbergia Sissoo*) and *bakli* (*Anogeissus latifolia*). These experiments showed that these timbers will meet the requirements and produce a better ski than those made from Kashmir ash, but seasoned timber is essential.

There are doubtless many Forest Officers who, when snowbound, would like to avail themselves of the opportunity of ski-ing and the Ski Club of India, now with nearly 200 members, will be only too willing to help and advise any sportsmen. The Honorary Secretary, Rawalpindi, will be only too ready to answer any enquiries and to receive any suggestions whereby Indian timbers, by suitable selection and preparation, can be utilised for the production of a real good Indian ski.



The Fir Forests of Gulmarg, Kashmir

Above the Fir Forests. Killanmarg Hut (10,200 ft.).

SANDALWOOD AND ITS INDIAN SUBSTITUTES

BY K. A. CHOWDHURY, WOOD TECHNOLOGIST,
FOREST RESEARCH INSTITUTE.

Introduction.

True sandalwood (*Santalum album*) has the reputation of having been used in India from ancient times, for, in classical Sanskrit literature, frequent mention is made of this wood as '*chandana*.' The demand for sandalwood has gradually increased, and since its supply is limited, various aromatic timbers from different parts of the world have been put on the market as substitutes for sandalwood. Amongst these, the most well-known are :—*Fusanus spicatus* R. Br.* (Australian sandalwood), *Esenbeckia atata*, Pittier, (West Indian sandalwood) (5), *Amyris balsamifera*, L. (Venezuelan sandalwood) (5), *Ximenia americana*, L. (West African sandalwood) (7), *Osyris tenuifolia*, Engl. (East African sandalwood) (1), and *Mansonia Gagei*, Drum. from Burma (2).

True sandalwood is a native of South India and its distribution is confined to Mysore, Coorg, the Southern Maharatta countries, the Carnatic and the Western Ghats. Occasionally, this tree is cultivated outside its natural zone, but the main supply is from the localities mentioned above.

Although the knowledge of an Indian substitute for true sandalwood can be traced back to the European literature of the thirteenth century, yet its botanical name was not known till recently, when Prain reported to the Linnean Society the identification of this tree as *Mansonia Gagei*, Drum. locally called '*kalamet*' in Burma (8). Due to certain similarity in the general properties of sandalwood and *kalamet*, there exists in commerce some confusion regarding their identity. The purpose of this paper is to consider the question of similarity of the two woods and the means of separating them.

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*Botanical name of this tree seems to be a matter of controversy among Systematic Botanists. *Fusanus spicatus* R. Br. is the name given to it by R. T. Baker, in his book 'Hardwoods of Australia.'

SANDALWOOD.

Santalum album, Linn. (*Santalaceæ*).

General Properties of Wood: Sapwood white, often with a yellowish tinge; heartwood brownish grey, streaked with alternate light and dark bands; oily, with a smooth feel; with characteristic strong odour; heavy to very heavy, weight per cubic feet approximately 60 lb.; moderately hard; almost straight grained; very fine and even textured.

*Description of Wood**: *Growth rings* fairly distinct, marked by bands of denser fibrous tissue; 7-14 per inch.

Pores appear like white dots to the naked eye, individually distinct with a hand lens, for the most part solitary, rarely in groups, rather irregularly arranged (Photo No. 1).

Soft tissue not distinct even with a hand lens.

Rays fine, visible with a hand lens, showing irregular arrangements on the tangential surface (Photo No. 3).

Material: D. 33, D. 2307, W. 6016, and W. 6722.

KALAMET.

Mansonia Gagei, Drum. (*Sterculiaceæ*).

General Properties of Wood: Sapwood dull white, heartwood blackish grey; oily, with a smooth feel; with characteristic faint odour, very unlike that of sandalwood; heavy to very heavy, weight per cubic feet approximately 60 lb.; hard to very hard; slightly twisted grained; fine and even textured.

Description of Wood: *Growth rings* rather indistinct, delimited by narrow bands of dense fibrous tissue; 12-24 per inch.

Pores minute, just visible with a hand lens, rarely solitary, mostly in groups, arranging more or less in radial rows (Photo No. 2).

Soft tissue not distinguishable with a hand lens.

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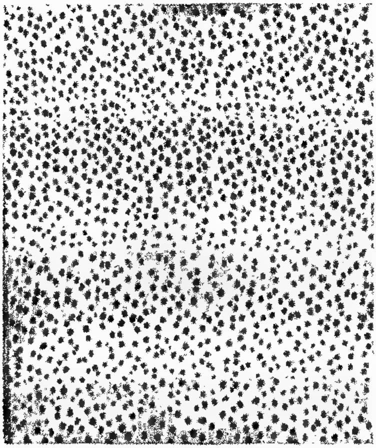
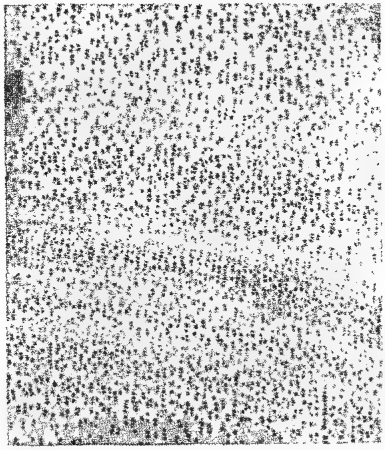
*This description is confined to the characters visible either with the naked eye or with a hand lens (10X).

1.



SANTALUM ALBUM, Linn.
Cross Section.
X. 10.

2.

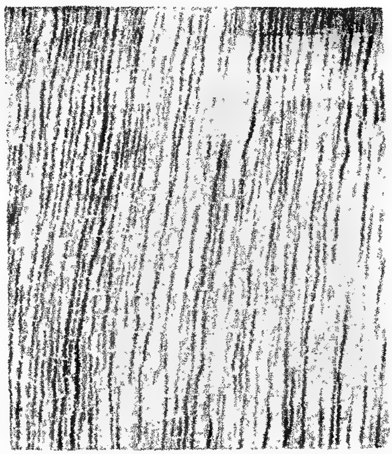


MANSONIA GAGEI, Drum.
Cross Section.
X. 10.

3.

SANTALUM ALBUM, Linn.
Tangential Section.
X 10.

4.



MANSONIA GAGEI, Drum.
Tangential Section.
X 10.

Photomicrographed by K. A. Chowdhury.

Rays fine, just visible with a hand lens, on the tangential surface showing distinct ripple marks (Photo No. 4).

Material: B. 6788 and B. 6827. In this connection, it is interesting to note that our type specimen number B. 1950 collected from Burma, bears the name *Santalum*, but on examination proved to be *Mansonia Gagei.*

SUMMARY:—

1. Sandalwood has a strong odour, while that of *kalamet* is rather faint.
2. In sandalwood the pores are solitary and individually distinct with a hand lens, but in *kalamet* the pores are just visible with a hand lens and they are arranged in radial rows.
3. Sandalwood has no ripple marks, while *kalamet* shows pronounced ripple marks.

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THE BARK-EATING PROPENSITIES OF THE FLYING SQUIRREL.

BY A. E. OSMASTON, I.F.S., PRINCIPAL, FOREST COLLEGE, DEHRA DUN.

Whilst touring in the Kulu Forest Division, Punjab, during April and May 1931, I observed the bark of the blue pine (*Pinus excelsa*) damaged in a way which I had not noticed either in the Chakrata or Garhwal divisions of the United Provinces where I had previously made the acquaintance of this pine to some extent. The damage was studied on the 15th and 16th May in Tos Nal compartment 5 at an elevation lying round about 9,500 feet. The general aspect of the forest at this particular spot is south-east on steep ground sloping down to the Tos Nal stream some 200 feet below. The forest is composed of nearly pure virgin blue pine of good quality.

Before I noticed the form of damage I am about to describe, I had already remarked on the unusual number of blue pine cones which had been eaten by flying squirrels. I had no time to obtain statistics, but I roughly estimate that there were as many stripped cone-axes lying on the ground as there were undamaged cones. It was then seen that some trees bore scars on the stem where the bark had been removed and the local inhabitants informed me that this was certainly caused by stones brought down by avalanches during the winter. A closer examination from the ground showed that this explanation was not correct, since the scars were present more or less equally all round the stem though, on account of the steepness of the ground, only easily visible on the upper side. The nature of these scars is very clearly seen in Plate 24.

I had ten trees felled and I selected those on which the scars were especially numerous. In order to save time and labour, no tree over 16 inches diameter at breast height was felled. Before the last trees had been felled I luckily discovered some absolutely fresh scars and searching beneath these trees I found the strips of fresh bark scattered over the ground. I was now convinced that the author of the damage was a flying squirrel and the present evidence leaves, I believe, no possible room for doubt, though

Scars showing where the bark of Pinus excelsa has been stripped off by flying squirrels.

those requiring absolute proof in the form of an ocular demonstration are still entitled to be sceptical. I roughly estimate that one-third of the trees over 10 inches diameter, within the piece of forest I saw, bore either new unhealed or old healed scars. An exhaustive examination would have been difficult owing to the steepness of the ground which limits an easy view to the upper side of the stem.

Out of many hundreds of scars seen, none was observed below 20 feet from the ground, though they were quite common on stems of a suitable size down to 25 feet from the ground. The marked absence of scars below 25 feet from the ground, even on stems of suitable dimensions, I attribute to the squirrel's dislike of remaining close to the ground. Whenever I have observed flying squirrels at night, I have always seen them rapidly ascend the tree for some distance after alighting low down on the stem. Probably other observers will bear me out in this. The only factor limiting the height above ground at which scars might be found seemed to be a preference for stems the bark of which was clean and smooth representing a vigorous and healthy condition. Thus scars were seen up to an estimated height of 80 feet on trees which were not yet fully mature.

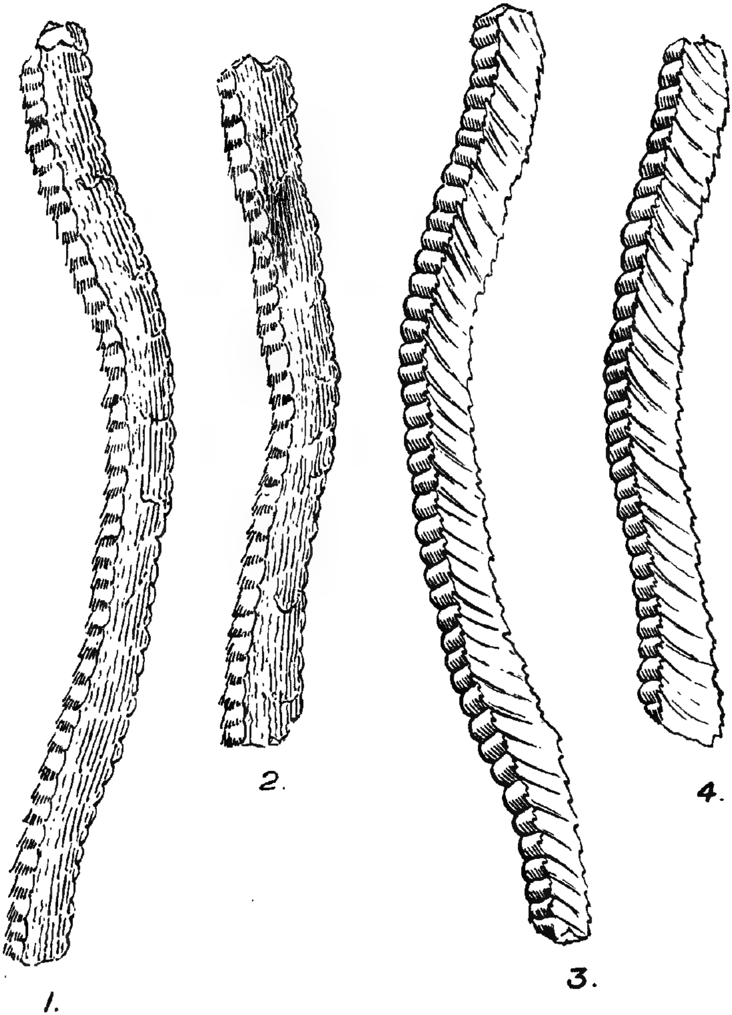
The data from the felled trees, eight of which were examined in great detail, show that only portions of the stem varying between 3 and 8 inches diameter and averaging 7 inches diameter bear unhealed scars. Nevertheless I actually saw such scars on portions of unfelled stems where the diameter seemed to be about 10 inches. The limitation of stems to those having a diameter between 3 and 10 inches is certainly due to the thinner and possibly more succulent bark on such portions of the stem. It was observed that no fresh wound was ever made on a stem the bark of which had become very rough, and a strong preference existed for clean smooth bark. There seemed also to be some preference for fast-growing wood, though this was not a limiting factor in any way since the rate of growth on the trees examined varied from 5 to 12 rings to the inch at the points where there were fresh scars. Similarly the age of wood bearing scars varied from 13 to

33 years with an average of 20, after deducting the age of the scars.

Another very noticeable fact is that the bark is almost invariably removed within a distance of 12 inches measured from a side branch immediately beneath. Actually, the bark is in most cases removed from within a distance of 6 inches of a lower branch. Presumably 12 inches is the distance to which a squirrel can conveniently stretch. Out of 130 scars examined on the felled trees only two were immediately beneath a branch and both these scars would have been easily reached by the squirrel from above. Several scars extended almost completely round the stem, though complete ringing was only seen in one instance. There seems little doubt that the top portion of a stem may occasionally be killed in this way, though no completely dead top due to ringing was found.

Exactly how the squirrel commences the attack is uncertain, but an examination of the fallen strips of bark, two of which are depicted in the accompanying plate, shows that the squirrel having once made a start continues to gnaw off strips by working along the exposed edge of the bark. Plate 25 shows clearly the regular tooth marks along the edge of the strip and also the grain of the bark running crosswise. This also indicates that the strip is not peeled off lengthwise by means of a straight pull, as might have been reasonably supposed. The strips varied from ·3 to ·6 of an inch wide and from 1 to 5½ inches long. The average of 140 such strips picked up off the ground at random was about ·4 inch by 3 inches. It appears as if the soft juicy tissues from the inside of the bark are eaten. I found no tooth or claw marks on the surface of the wood from which the bark had been freshly removed, so presumably the sap alone is not considered a special delicacy.

The morning after I had collected the data given above I was walking before dawn with a lantern beneath some silver fir (*Abies Webbiana*) trees about ¼ mile further up the valley, and I was startled by the rather catlike call of one of these flying squirrels in a silver fir immediately above my head. When it was



Strips of bark, natural size, of Pinus excelsa removed by flying squirrels. Nos 1 and 2 outer surface Nos. 3 and 4 inner surface

light I found the ground strewn with the shoots of the silver fir, many of which had been stripped by the flying squirrel of their immature male inflorescences. The squirrel's bark-eating propensities are probably restricted to the months of April and May when the sap is rising, though this requires confirmation.

It is most unfortunate that I was unable to procure a specimen from which the species could be identified. The call I heard was exactly similar to that of *Petaurista inornatus*, the Large Red Flying Squirrel which I know well both wild and in captivity, so that I suspect this species of being the true culprit. On the other hand the Honorary Secretary of the Bombay Natural History Society informs me that the locality would not exclude the Lesser Flying Squirrel *Eoglaucomys fimbriata* and possibly also *Petaurista birrelli* which is found in the Murree hills.

RETENTION OF STANDARDS IN SAL (SHOREA ROBUSTA) REGENERATION AREAS SUSCEPTIBLE TO HILL* FROSTS.

BY M. D. CHATURVEDI, I.F.S., SILVICULTURIST, UNITED PROVINCES.

1. In the sal regeneration areas where plenty of established advance growth exists on the ground, the removal of the overwood usually presents a difficult problem. Opinion on this question has crystallised into two distinct schools of thought, one advocating the total removal of the upper canopy in a single operation (clearfelling) and the other prescribing the retention of a few standards varying from 15 to 30 trees per acre to shelter the young shoots for the first few years against frost, drought and excessive weeds. The manipulation of the upper canopy over regeneration areas has been a subject of acute controversy for the last decade or two and now the problem seems to have reached that stage when interest begins to flag and, like other classic controversies, it has been allowed to sink into oblivion with the remark that much could be said on both sides.

* Hill frosts as opposed to plains frosts. The former occur in the foot-hills of the Himalayas and are caused by cold air filling up in the hollows and valleys. The latter are radiation frosts and occur in the *tarai* areas of Pilibhit, South Kheri, etc.

2. The arguments in favour of the retention of shelter trees over regeneration areas briefly stated are:—

i. That 25 to 30 trees per acre left as standards over advance growth provide considerable protection against œcological factors, which may adversely affect the subsequent development of the young shoots. Thus, the maintenance of an upper canopy discourages to some extent both the spread and the growth of weeds, minimizes the effects of frosts, affords a measure of protection to the soil, and in years of extreme droughts conserves the moisture content of the soil and secures comparatively low temperatures.

ii. The standards periodically disseminate seed to sow up the blanks and a fresh crop of seedlings is obtained, which, given favourable conditions, will grow into saplings and poles. The existence of mother trees in a regeneration area is an invaluable security against accidents like frosts or fire, which may cause the whole of the advance growth to disappear, and when, but for a fresh stock of seedling recruits which may yet be obtained from the standards, the area is likely to lapse into a mass of dense weeds and climbers.

3. While none of these advantages considered separately may suffice to justify the retention of shelter trees, the total cumulative effect of the factors considered above may be to produce conditions favourable for the factors of growth to operate.

4. Those who advocate the entire removal of the upper storey rely mainly on the hypothesis that established regeneration of sal requires uninterrupted overhead light for its subsequent development; and that the overwood which is sufficient to protect sal shoots against adverse factors, notably frost, is also sufficient to cut off the light incident on the young regeneration; causing thereby a corresponding drop in their increment compared to which, it is urged, the advantages of protection are of doubtful value.

5. Whether a few standards to an acre can interrupt sufficient overhead light to make any discernible difference in the increment of young shoots is an open question, particularly when it is remembered that the light necessary for the photosynthetic purposes of a plant need not be of very high intensity. As a matter of fact it was demonstrated by Fricke (1) in 1904 that in temperate zones pine seedlings could live on diffused light under a heavy canopy, provided the root competition with older trees was eliminated. The importance of *complete* overhead light in the development of established advance growth would seem to be, therefore, unduly exaggerated.

6. Attention may also be drawn to the root competition of old trees interfering with the development of the advance growth which is entirely eliminated if the overwood is completely removed. It is suggested that it is in the root competition, rather than in the doubtful limitation of light occasioned by a scattered overwood, that the main objections against the retention of shelterwood over regeneration areas may lie.

7. The inconvenience involved in the management of areas, in which standards are removed after the young shoots have reached an age of 5 to 10 years, and the consequent damage caused to the young crops during the fellings in the overwood, inclines one in favour of the clearfelling in a manner in which nothing else does. The difficulties of management are mainly responsible for the prejudice against the shelterwood and this has focussed attention on the alleged benefits accruing from an overwood in regeneration areas.

8. The nature of protection against frosts afforded by shelter trees to young sal crops has been recently examined by Mr. A. E. Osmaston (2). He distinguishes frosts in Upper India as hills and plains types. The former are met with in submontane division after long intervals, while the latter occur in the plains more or less annually. The hill frosts are as severe as they are rare and kill the tops of trees irrespective of their size. The taller trees seem to suffer even more than smaller trees. A measure of the intensity of frost in a given year is provided by the size of the trees

which are affected. Thus, for example in the Dehra Dun Division the severe frost of 1904-05 killed poles 1 to 2 feet in girth within 5 to 15 feet from the ground, while poles under 1 foot in girth were killed back almost to the ground level. Large trees escaped with little damage, although in regions where extremely low temperatures prevailed (Bengal) trees up to a height of 60 feet were killed back to the ground level*. The plains frosts are characterized by their frequency, forming as they do, an annual feature in places like Pilibhit, South Kheri and the *tarai* areas. Only young exposed trees are affected by these frosts and generally a little shelterwood is enough to minimize the damage considerably. They seldom affect anything above 10 feet in height.

9. While, therefore, the value of the protection afforded by the shelter trees to the young shoots against plains type of frost in the *tarai* areas cannot be denied, it is doubtful whether the protection is at all effective in regions where hill frosts occur. It is an undeniable fact that in a year of severe frost such as characterized the year 1904-05, the damage to young shoots and poles is entirely independent of the overwood which offers little, if any, protection at all. In localities susceptible to hill frosts which periodically assume extreme severity, the utility of leaving a scattered shelterwood over regeneration areas has been recently questioned by Messrs. A. E. Osmaston (3) and J. R. Singh. The period which elapses between two sharp frosts varies between 5 to 20 years†; but milder types of frosts occur almost once every 5 years. The retention of upper canopy, however superfluous it may be when an extremely severe frost occurs, may still afford a measure of protection in years characterized by light frosts.

10. To lift this controversy from the realm of speculation it s essential that attention be focussed on a physical magnitude, on

* A. L. McIntire's report on the 1904-05 frost damage in sal tracts in depressions n the Palamau and Hazaribagh Districts, Bengal. *Quoted* by Mr. A. E. Osmaston (3).

† In the Dehra Dun Division, severe frosts have been calculated by Mr. Osmaston (5) to have occurred in the year 1874, 1891, 1900 and 1905, and there is reason to believe that these frost years affected the whole of the sal bearing region lying at the foot of the Himalayas.

which the influence of overwood may be capable of measurement. The effect of the shelter afforded by scattered standards in a regeneration area expresses itself best in the increment of the young shoots growing under conditions which are said to offer protection against extreme colds, excessive heat, drought, dessication and inroads of weeds. A comparison of the increment of young shoots growing under a scattered shelterwood and in the open is about the surest method of ascertaining the influence, if any, of the protection afforded to them by the overwood against adverse factors.

11. With this object in view two plots, 10 acres each, were laid out in 1921 near Lachiwala (compartment 7) in the Dehra Dun* Division by Mr. M. P. Bhola at the instance of Mr. C. G. Trevor. The upper canopy in these plots was manipulated as under :—

Sub-plot a	...	Overwood, nil (clearfelled).
Sub-plot b	...	Overwood, 25 trees to an acre were left.

In both the plots all trees and all advance growth was cut

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* DESCRIPTION OF THE LOCALITY :—

Height above mean sea level—2,200 feet.

Climate ...	...	Cold weather which lasts from October to March is usually characterized by heavy dew precipitations during November and late sharp frosts which periodically assume great severity. Temperature continues to rise thereafter till the break of rains in June-July followed by the rainy season which lasts till October.
Mean annual rainfall	...	On an average 68 inches, out of which about 6 inches falls during the cold weather.
Rock, soil, and humus	...	A fairly deep well-drained loam overlying boulders. The humus is fairly well decomposed.
Aspect and slope	...	Sloping gently towards south-west. The area is cut up by mild ravines.
Type of forests	...	Sal poles admixed with miscellaneous species notably *Terminalia tomentosa* (*asna*) and *Ougeinia dalbergioides* (*sandan*) with occasional *Eugenia Jambolana* (*jamun*) and *Dablergia Sissoo* (sissoo).

back. After the removal of the saleable material a fire was run through the area on the 2nd April, 1921, and the new shoots began to appear shortly afterwards.

12. The young coppice shoots both in the clearfelled and shelterwood plots had an extremely mild cold weather to encounter during the first year (1922) of their life. Despite this, the clearfelled plot showed signs of being lightly touched by frost, while the shelterwood plot remained completely immune. The following year (January 1923) was characterised by a comparatively severe frost and all shoots under 6 feet in height were affected in the clearfelled plot, while frost damage was conspicuous by its absence in the shelterwood plot. In an adjoining shelterwood plot which was formed a year later; the frost damage to one-year old shoots was negligible compared to the damage caused to two-year old shoots growing in the clearfelled area. The growth of coppice shoots in the clearfelled plot might have easily been considerably retarded had there been a severe frost the very first year. The accident of the first winter being mild gave the shoots a start, and before the frost occurred the following year, most of them had gone above 6 feet, a height above which frost did little or no damage. The following years 1924, 1925, 1926 were characterized by particularly mild winters with little or no frosts, and the shoots both in the clearfelled and the shelterwood plots had gone well above 20 feet when the severe frost of 1927 occurred and even then it affected the clearfelled plot much more than the shelterwood plot. Whatever little damage there was in the latter area was confined to a narrow strip along the roadside only.

13. To study the comparative rate of growth of the new shoots under varying degrees of overwood a sample plot in each of the shelterwood and clearfelled areas was laid out in October 29, 1924. Whatever protection the scattered standards afford against frost, drought, excessive weeds, and other adverse factors will find an eloquent expression in the accelerated increment of the young shoots in the shelterwood area compared with the clearfelled area.

14. A comparison of the two sample plots is given below :—

TABLE I.

Species.—*Shorea robusta* (sal).

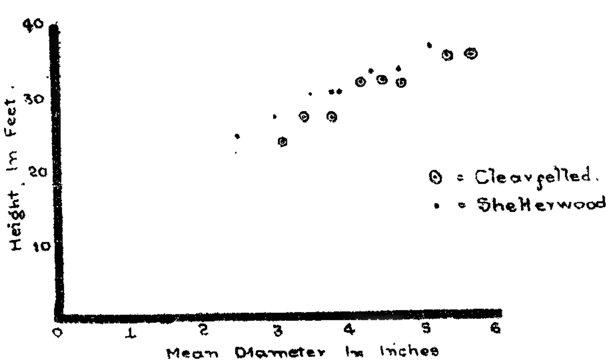
Age.—The coppice dates from April 2, 1921.

Plot No.	No. of trees per acre after thinning.	AVERAGE HEIGHT OF.		FORM FACTORS.			DIAMETER.			Basal area per acre after thinning (sq. ft.)	VOLUME PER ACRE.			
		Tallest trees (Ft.)	Crop (Ft.)	Stem timber.	*Smallwood.* Stem.	*Smallwood.* Total.	Minimum (inches).	Maximum (inches).	Average (inches).		Stem timber c. ft.	*Smallwood.* Stem. c. ft.	*Smallwood.* Total. c. ft.	Total c. ft.
October 1924.														
33 (Clearfelled)	1,108	19	19	nil	0·403	0·403	1	4	2·3	32·41	nil	248	248	248
34 (Shelterwood)	995	18	18	nil	0·328	0·328	1	4	2·2	26·64	nil	157	157	157
November 1928.														
33 (Clearfelled)	595	32	29	nil	0·471	0·471	2	7	3·9	49·58	nil	677	677	677
34 (Shelterwood)	793	33	26	nil	0·472	0·472	1	6	3·2	43·83	nil	538	538	538

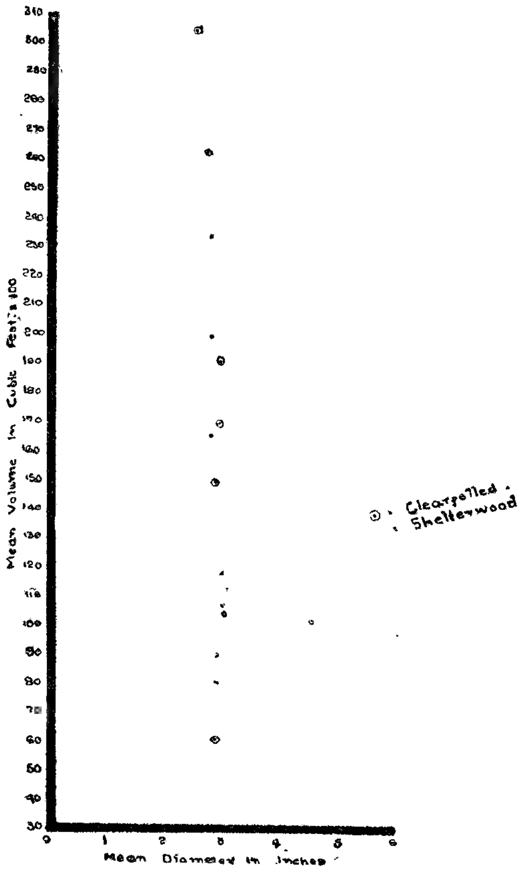
15. It will be seen that these sample plots are init paet lightly different in stocking (the clearfelled plot being about 10 per cent. higher than the shelterwood plot) and unless absoluritysially between all factors except overwood is secured for both plots, it *is not possible to attribute any differences in height, volume* or increment to the protection afforded by shelter trees alone. An instructive comparison between these plots can be instituted despite this small difference in stocking. Thus, reducing the stocking of the clearfelled plot by about 10 per cent. and its volume in the same proportion, the volume of the shelterwood plot will yet be about 30 per cent. less than that of the clearfelled plot. At the 1928 measurement the volume of the clearfelled plot is indisputably better than that of the shelterwood plot being about 20 per cent. higher with a stocking 25 per cent. lower. Although, this comparison is based on a single pair of plots, the difference in their volumes is so overwhelmingly great that the personal factor in the choice of these plots and their measurements and errors in equalizing small differences of stocking cannot explain it away. A great deal of the superiority of the clearfelled plot over the shelterwood plot must be ascribed to the absence of standards.

16. The frost damage to these plots is also extremely instructive. The stocking of the clearfelled plot was reduced in 4 years by about 46 per cent., out of which the frost of 1927 accounted for 40 per cent., the remaining 6 per cent. were removed in thinnings. In the shelterwood plot, on the other hand, out of the 20 per cent. reduction in the growing stock during the same period, hardly 2 per cent. was due to frost.

17. About 30 indicator trees were also felled in each of the plots to compare their development under conditions which obtained in the clearfelled and shelterwood plots. The height development of individual trees was better in the shelterwood



plot than in the clearfelled plot. For any given diameter the height of a tree growing in the open (clearfelled plot) was less than under the shelter of standards. The reason for this is not far to seek. In the shelterwood plot, the proximity of standards tends to cut off the supply of light, for which young shoots have to strain themselves upwards, a contingency which does not arise in the clearfelled plot. The volume of single trees, for a given diameter, was similarly slightly higher in the shelterwood plot than in the clearfelled plot. The stocking of the clearfelled plot was also comparatively deficient owing to higher mortality from frost.



18. Where, however, the clearfelled plot scored over the shelterwood plot was in having a much larger number of shoots of higher diameters *per unit area* and as such a bigger volume despite comparatively poor stocking. The shelterwood plot owing to less mortality from frost had a denser stocking and this coupled with the presence of standards retarded the development of shoots on the whole.

19. Another pair of plots was laid out in Timli (Dehra Dun) about the same time. These plots also furnish ample evidence in favour of clearfelling.

CONCLUSIONS.

20. (*a*) When mild hill frosts occur, the protection which standards (25 to an acre) afford to the young shoots is established beyond any doubt by the plots described above. The mortality due to frost was invariably higher in the clearfelled plot than in the shelterwood plot. Even the mildest frost did not spare the clearfelled plot, while the shelterwood remained fairly unaffected.

(*b*) Owing to frost damage the stocking of the clear-felled plot was poorer than that of the shelterwood plot.

(*c*) The total removal of the overwood led to an accelerated development of the young shoots in the clearfelled plot. With the stocking reduced by frosts, the young shoots attained higher dimensions under full overhead light, than in the shelterwood plot crowded with standards and a denser stocking. Although for a given diameter the height and the volume of individual trees was inferior in the clearfelled plot, the total volume per acre, despite deficient stocking was very much higher than in the shelterwood plot, owing to there being a large proportion of trees of higher diameters per unit area in the clearfelled plot.

(*d*) While, therefore, the standards afford a certain amount of protection against mild hill frosts, there is no question about their adverse influence (whether due to root competition or cutting off of light) on the development of young shoots. Considering the fact that when severe frosts occur the protection which the standards afford is negligible, their retention for purposes of protection against mild frost is of doubtful value particularly when they retard the development of young shoots. This more than negatives the benefits of protection. The

damage which the ultimate removal of standards causes to young shoots (5 to 10 years old) is also an important point against their retention.

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FORMULÆ METHODS.

BY J. BANERJI, B.SC., B.COM., I.F.S.

In the determination of annual yield, the Working Plans Officer has at his disposal a large number of methods, almost all of which come under one or other of the three following main groups:

(*a*) Method of division into fixed annual coupes,

(*b*) Method of periods,

(*c*) Formulæ methods.

These methods have been thoroughly explained in all standard text-books on the subject (Schlich's Manual of Forestry, Vol. III, and Recknagel's Forest Working Plans). In this paper we are concerned with the third group only, *viz.*, the Formulæ methods. The special advantage of this group is that only the particular value of a few variables is to be determined and applied in the formula chosen, when the answer is obtained by a simple arithmetical process. The desirability of selecting one formula in preference to another is based primarily on the nature and the

extent of the difficulty in the determination of the unknown quantities.

Some of the well-known formulæ generally used in India are— (*a*) Heyer's Formula

$$Y = \frac{\text{real } G - \text{norm. } G}{a} - \frac{\text{Real increment of } a' \text{ years}}{a'}$$

(*b*) Austrian Kammeraltaxe (Carl Heyer)
(*c*) Hundeshagen
(*d*) Hufnagel
(*e*) Von Mantel

It will be seen that some of the above formulæ involve the determination of increment beforehand and, under conditions prevalent in India, this is almost an impossible task of indifferent accuracy and value. This leaves us with only those formulæ which involve determination of the growing stock alone, *i.e.*, Hundeshagen's and Von Mantel's. These two are based on the same principle and, if in the Hundeshagen's formula we replace the normal growing stock by the product of the final mean annual increment and half rotation, we get Von Mantel's formula, which, as a matter of fact, is the simpler of the two.

A large majority of Working Plans Officers have, therefore, taken shelter under either Von Mantel's original formula or one of its numerous convenient modifications. These modifications have originated in India owing mostly to the difficulty of applying Von Mantel's unadulterated formula in practice. Von Mantel's Formula lays down that if—

V = the real growing stock, *i.e.*, the total volume of the forest enumerated up to seedlings and each stem measured down to the growing point, and

R = the rotation, then

$\therefore$ the annual yield $= \frac{2V}{R}$.

Now let us discuss the particular difficulties which may arise in applying the formula in practice.

(1) The enumeration of the forest may not be carried down to seedlings. The common practice is to enumerate all stems above

a certain arbitrary and convenient diameter at breast height, which is often 8″ over bark. We shall call this the *lower limit of enumeration.* Similarly, we may have the *higher limit of enumeration* corresponding to the breast height diameter of the oldest age class. This latter is often the breast height diameter at rotation.

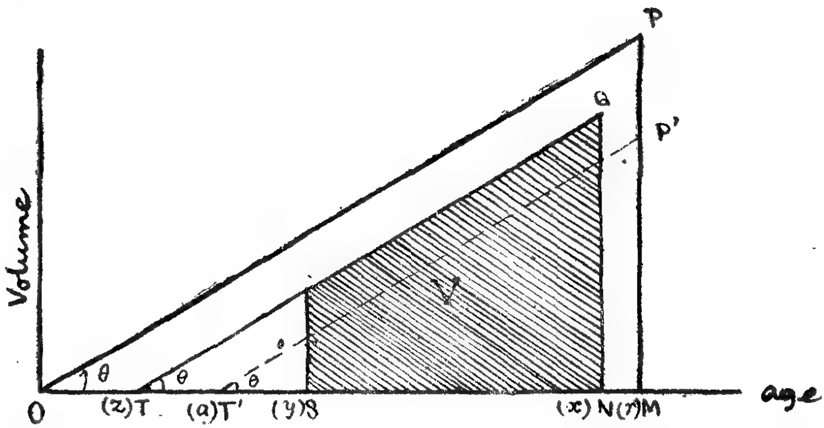
(2) After enumeration, the volume of each stem may not be measured right down to 0″ diameter at the thinner end of the stem (*i.e.*, down to the growing point). The common practice in India is to measure each stem down to 2″ diameter over bark (definition of smallwood). This diameter up to which a stem is measured is a variable and may, in a particular place, be conveniently fixed for our purpose. We shall call this the *bole measurement limit.*

(3) Again, when trees are felled and converted into logs, the diameter at the thinner end of the commercial bole, *i.e.*, of that part of the stem which is actually utilised, is a variable and changes from time to time and place to place. This diameter may be the bole measurement limit as explained above, or may be anything else. We shall call this the *conversion limit.*

In Von Mantel's Formula it is assumed that both the conversion limit and the bole measurement limit are zero. The lower limit of enumeration is zero, while the higher limit of enumeration corresponds to the breast height diameter at rotation age. If these conditions are not satisfied, it is a mistake to apply Von Mantel's Formula. But it is impossible to satisfy all these conditions in practice and, therefore, the practical application of Von Mantel's original formula becomes difficult and may lead to considerable error.

Most of the modifications of Von Mantel's original formula allow a partial enumeration of the growing stock, *i.e.*, a variable in the shape of a convenient lower limit of enumeration is introduced in them. Both the conversion limit and the bole measurement limit is zero in most of the modifications: only in Smythies' Formula (see *Indian Forester*, December 1922) both these limits are assumed equal to the lower limit of enumeration. We shall now try to establish a general formula which will show us the

correlation between the different modifications of Von Mantel's original Formula.



In the figure above let the horizontal and vertical axes represent respectively the age and volume of a normal forest. Let OP, the age-volume line make an angle θ with the age axis. If r is the rotation and OM represents r, then PM, the ordinate at M, will represent the yield. This yield includes the total volume of all wood in the rotation-age class (*i.e.*, the bole measurement limit and the conversion limit are both zero).

Let ON ($=x$) represent the age corresponding to the breast height diameter (x') of the upper limit of enumeration (*i.e.*, the enumerations are carried up to a *B.H.D.* x'). Again, let OS ($=y$) be the age corresponding to the breast height diameter (y') of the lower limit of enumeration, *i.e.*, the enumerations are carried down to a *B.H.D.* y'. Let OT ($=z$) represent the age corresponding to the ground level diameter z', the bole measurement limit. Then the ordinate at T represents the volume of all trees with a ground level diameter z'. Through T draw a straight line TRQ parallel to OP, cutting the ordinates at S and N at R and Q respectively. Then the figure $RSNQ$ represents the actual volume (V) arrived at when the enumeration figures are converted into corresponding volume figures: and is the partial volume of all trees whose breast height diameter falls within the range between x' and y' and the length of whose stems has been measured down to the bole measurement limit z'. Finally, let GT' ($=a$) represent

the age corresponding to the ground level diameter a', the conversion limit. Through T' draw $T'P'$ parallel to OP, to meet PM at P'. Then $P'M$ represents the yield actually used, or the outturn. We shall find a relation between $P'M$ ($= Y$ say) and $RSNQ$ ($= V$).

$$Y = P'M \quad = (r-a)\ \tan\theta \ldots\ldots\ldots\ldots (1)$$

$$V = RSNQ = \tfrac{1}{2}(RS + QN)\ SN$$

$$= \tfrac{1}{2}\left\{ (y-z)\ \tan\theta + (x-z)\ \tan\theta \right\} (x-y)$$

$$= \tfrac{1}{2}(x-y)\ (x+y-2z)\ \tan\theta \ldots\ldots (2)$$

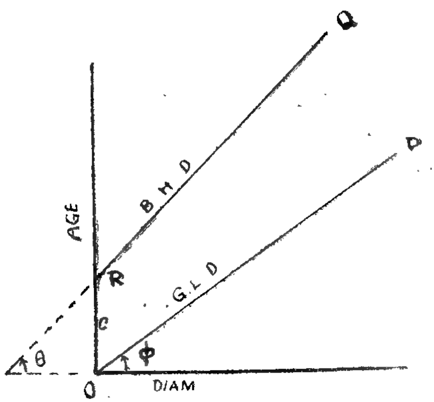
Eliminating $\tan\theta$ between (1) and (2), we get

$$\frac{Y}{r-a} = \frac{2V}{(x-y)\ (x+y-2z)} \qquad \text{or}$$

$$Y = \frac{2V(r-a)}{(x-y)\ (x+y-2z)} \ldots\ldots\ldots\ldots (3)$$

This is the general formula. This represents the yield when enumeration has been carried out between x and y years old trees with a measurement limit z' and conversion limit a'.

Moreover, if a direct linear relation be assumed to exist between diameter and age, we can, in the above formula, replace age with diameter. Of course it is sometimes too much to assume the existence of such relation; but wherever such relation can be taken for granted with a reasonable degree of accuracy, we can modify our present formula. In order to do that, let us assume a relation between diameter and age, represented by the following figure.



Let the horizontal axis and the vertical axis represent respectively the diameter and age. Let RQ which cuts the age-axis at R at a distance 'c' from the origin O, represent the growth of breast height diameter, while OP represent the growth of ground level diameter. Let OP and RQ make angles ϕ and θ respectively with the diameter-axis. It is to be noted that 'c' represents

the time taken to reach a height of 4′ 6″ (*i.e.*, the breast height). Then in formula (3) above :

$x =$ Age corresponding to a *B.H.D.* of x'

$= c + x' \tan\theta$. Similarly :

$y = c + y' \tan\theta$

$z = z' \tan\phi$

$a = a' \tan\phi$

$r = c + r' \tan\theta$, where r' is the *B.H.D.* corresponding to rotation. Substituting these values of x, y, z, r and a in formula (3), and removing the dashes, we get,

$$Y = \frac{2V\ (c + r\tan\theta - a\tan\phi)}{(x-y)\ \{(x+y)\tan\theta + 2\,(c - z\tan\phi)\}\tan\theta} \quad \ldots \quad (4)$$

Here x, y and r represent the breast height diameter of the higher and lower limit of enumeration and of the rotation age: z represents the bole measurement limit and a represents the conversion limit.

Now we shall establish all the well-known formulæ from Formula (3) above.

(*a*) Von Mantel's Formula

In Formula (3), put

$x = r$

$y = o$

$z = o$

$a = o$; then, we get

$$Y = \frac{2V\,(r-o)}{(r-o)\,(r+o-o)} = \frac{2Vr}{r \cdot r} = \frac{2V}{r}$$

(*b*) Howard's Formula (*Indian Forester*, August, 1920)

In the general formula, put

$x = r$

$y = \frac{1}{2}r$

$z = a = o$; then, we get

$$Y = \frac{2V\ (r-o)}{(r-\frac{1}{2}r)\ (r+\frac{1}{2}r-o)} = \frac{2Vr}{\frac{1}{2}r\ 3/2\ r} = \frac{V}{3/8\ r}$$

(*c*) Burma Formula

In the general formula put

$x = r$

$y = r/3$

$z = a = O$; then we get

$$Y = \frac{2V(r-o)}{(r-r/3)\ (r+r/3-o)} = \frac{2Vr}{2r/3 \cdot 4r/3} = \frac{V}{4r/9}.$$

This formula is almost similar to Howard's Formula, except that the lower limit of enumeration here is $r/3$ instead of $r/2$. It should be noticed that both in Howard's and Burma Formula, the measurement limit and the conversion limit are zero. This makes the formulæ slightly inaccurate to apply in practice.

(*d*) Smythies' Formula (*Indian Forester*, December 1922)

In the general theorem put

$x = r$

$y = y$

$z = a = y$, then, we get

$$Y = \frac{2V(r-y)}{(r-y)\ (r+y-2y)} = \frac{2V\ (r-y)}{(r-y)\ (r-y)} - \frac{2V}{r-y}$$

It is to be noted that the lower limit of enumeration, the measurement limit and the conversion limit are all the same and equal to y, which, in the United Provinces, is generally 8″.

(*e*) Blanford and Simmons' Formula

In the general formula put

$x = r$

$y = y$

$z = a = o$; then we get

$$Y = \frac{2V\ (r-o)}{(r-y\ (r+y-2 \cdot 0)} = \frac{2Vr}{r^2-y^2}$$

Multiplying the denominator by r^2/r^2, we get

$$Y = \frac{V}{\frac{1}{2}\ r\ (1 - \frac{y^2}{r^2})}$$

It should be noted that four of the above formulæ assume $z = a = o$, while Mr. Smythies assumes $z = a = y$, the lower limit of enumeration. That is why we can derive Von Mantel's, Howard's

and Burma Formulæ from Blanford and Simmons' Formula, but not Smythies' Formula. We have kept the lower limit of enumeration, the measurement limit and the conversion limit independent variable in the general formula (3): hence we can derive all the formulæ from it.

ARTIFICIAL REGENERATION WITH SELECTION SYSTEM IN MIXED FORESTS.

BY E. M. CROTHERS, I.F.S.

This was one of the many problems of the day discussed at the Third Silvicultural Conference that assembled at Dehra Dun in March 1929.

The Conference recorded its opinion in a resolution, the first portion of which ran as follows:—

"That this Conference considers that artificial regeneration of light demanding species in gaps caused by fellings made under the true Selection system is not likely to be successful".

The resolution concludes by calling for a further report to the next Conference. It may perhaps be permissible to record any experience one may have had in the application of such a system of regeneration, and to add a few suggestions for consideration.

Between 1912 and 1915 the writer held charge of the eastern forests of South Coorg, which are very similar to the forests in which Mr. Laurie conducted his experiments. The system of management applied to the South Coorg forests at the period I refer to was Selection *cum* Improvement fellings, thinning of patches of promising regeneration of the principal species, and artificial regeneration of gaps caused by the Selection fellings.

The Officer-in-charge had a free hand to regenerate the gaps with any of the principal species, which were teak, rosewood, *Pterocarpus Marsupium*, *Terminalia tomentosa* and *Lagerstroemia lanceolata*.

It was soon discovered that gaps in areas where bamboos (*Bambusa arundinacea*) occurred could not be regenerated with

teak. A gap of about 40′ × 40′ surrounded by bamboo growth 120′ high, did not receive half as much light as teak regeneration would need, apart from the question of drip which I will refer to again later on.

Such blanks could, however, be regenerated successfully with rosewood or *Pterocarpus Marsupium.*

With extreme care and attention a fair degree of success was obtained, but yet this system of regeneration and with it the system of management had to be abandoned for reasons given below.

There were two felling series, one in each of the 2 Ranges of the subdivision. The selection fellings usually left from 1,000 to 1,200 gaps per coupe to be regenerated.

The gaps under regeneration needed attention for at least 3 years, weeding and aeration 2 to 3 times a year according to the intensity of the monsoon, felling or girdling of inferior species on the periphery of gaps to maintain the right degree of light to suit the requirements of the developing seedlings, and the removal of over-hanging branches to save seedlings from the evil effects of drip. Here I will pause to remark that in his note read at the Conference Mr. Laurie stated that drip did not seem adversely to affect the seedlings. But, on the other hand, Mr. Laurie recorded the fact that in the year of his experiment the south-west monsoon was very poor, the rainfall being less than one-third of the average.

In a year of normal rainfall I am sure Mr. Laurie will find drip fatal to teak seedlings.

To resume where I broke off.

In 3 years it was found that there were from 3,000 to 3,600 gaps in coupes per range needing close attention. It was impossible to continue to deal satisfactorily with such a large number of scattered patches of regeneration with a reasonable prospect of the number of patches increasing as the working proceeded. Small scale experiments, I have no doubt whatever, will give satisfactory results and this is what misleads one, the crab in the system does not show up till it is applied to a full scale operation. If this

system of regeneration has to be applied to any forest I would suggest (i) The felling series be arranged to give per range coupes not exceeding 200 acres, (ii) The regeneration should precede the selection fellings. Gaps would have to be created in the vicinity of mature trees and regenerated in advance of the felling of the marked trees. The actual gap formed by the felling of trees would be neglected since there would be a patch of regeneration in the immediate vicinity. The procedure of the past would be reversed. Regeneration would precede the fellings instead of succeeding them. By adopting such an arrangement it would be impossible for the management to carry out the main fellings and to miss out the regeneration operations. Many readers will readily recall instances of how frequently this has happened in the past to the detriment of the forest.

If for any reason regeneration cannot be obtained a halt would be called to consider a change in the system of management, meanwhile the seed-bearers which would not have been felled would be there to assist in some other method of regeneration that may be evolved to suit the silvicultural requirements of the principal species.

CHITTOOR,
19*th May*, 1931.

VITALITY OF SCHLEICHERA TRIJUGA SEED.

BY P. N. DEOGAN, P.F.S., EXPERIMENTAL ASSISTANT TO THE SILVICULTURIST, F.R.I., DEHRA DUN.

Troup, in his "Silviculture of Indian Trees," says with regard to *Schleichera trijuga* "the seed does not retain its vitality long", but experiments at Dehra Dun have proved the contrary. Two hundred and fifty seeds collected in the beginning of September 1919 were sown on 30th March, 1920. Of these 99 germinated. The seed was stored in an ordinary envelope during these 7 months.

Again, 1,800 seeds collected locally on the 27th August, 1930, were sown on 1st September, 1930, after 24 hours' soaking in cold

water. The soil was worked to a depth of 1 foot with spades before sowing.

Germination commenced in the first week of October, 1930, and 68 seeds in all had germinated by the end of the month. The seedlings were used for routine experiments and, as no more germination was noticed, the bed was scraped clear on 3rd May, 1931. On the 10th May the bed was dug to a depth of 1 foot and *Terminalia tomentosa* seed was sown, the bed being watered as required. By the beginning of June some more *Schleichera* seedlings were noticed, and by the 20th June as many as 50 seedlings were counted. It was observed that all the seed thrown on the surface of the bed by the working of the soil for *Terminalia* sowings had rotted and a few that were picked up from underneath the soil were still germinating. The seeds which germinated were found to be about three-quarters of an inch below the surface of the soil.

INDIAN SHIKAR NOTES.

BY THE HON. J. W. BEST, O.B.E., LATE I.F.S.

The third edition of this well-known book has recently been published by the Pioneer Press for Rs. 6. The text has been revised and a chapter added on "Gram Fishing in the Central Provinces" by Major E. T. Walker, and the book is produced in a more attractive form. It is a pity, however, that the publishers are not clear as to the title. The original title of "Shikar Notes for Novices" was changed in the 2nd edition to "Indian Shikar Notes", as being more suitable to the English market. The present edition bears the latter title inside, but the original title has crept back on to the cover and into the advertisements in the "Pioneer." Another mistake, which appeared in the 2nd edition and has not been corrected, is in Appendix B, from which the close seasons for Sambur, Chital, etc., (mature stags), have been omitted.

On reading this excellent little book once again, one is more than ever impressed by its usefulness to the *shikari* and sportsman, more especially the beginner. It is full of sound practical advice and has no unnecessary padding. It is, of course, written with special reference to the Central Provinces, where the author had all his experience, but a great deal of the subject matter applies

in any part of India where similar sport is to be obtained. Chapter I in particular is generally excellent, and contains much sound advice that it would pay every big game *shikari* to take to heart.

The criticisms which follow of particular statements in this and other chapters are not meant to draw undue attention to what appear to be faults, and the book, as a whole, is full of useful hints and interesting information.

There are eight chapters on big and small game with notes on the habits and characteristics of the animals and birds dealt with, and hints as to the best methods for bringing them to bag. A Chapter on "Hunting a Bobbery Pack" will be found useful in any part of India where similar hunting is possible. The chapters on fishing and pig-sticking are very instructive to those stationed in the Central Provinces.

The following remarks apply more particularly to Chapters I to IV, which deal largely with tigers. The Chapters on the tiger are generally excellent. It is, however, a pity that the author has used the word "kill" so indiscriminately. It is unusual and rather muddling to describe a live buffalo tied up as a bait as a "kill", and on the same page to apply the same word to the dead buffalo after a tiger has killed it—the latter should be the correct use as actually stated on page 35.

It is interesting to note the author's experience that "a panther nearly always partially or wholly cleans out the entrails of its victim, but a tiger does so rarely". Most people will probably be inclined to agree with this statement, but I think it unwise to say that "a kill eaten from the buttock end only may be that of a panther (certainly if the entrails are cleaned out)...". The first tiger I had anything to do with was in the Central Provinces and it cleaned out the entrails beautifully, and I have seen other cases since. The statement above quoted might be very misleading to a novice who struck the exception the first time, as I did.

On the subject of *machans* for tiger beating every *shikari* has his own views. The *machan* as illustrated and described on pages 43 and 44 of the book has no doubt been proved satisfactory by the author in many beats, and he must have found that a large ladder

left against the foot of a tree does not attract the attention of a tiger or turn him away. Personally I should prefer not to run this risk, and to use more rope and time in tying my *machan*, and a light rope ladder if a ladder was necessary. The *machan* is described as 4 ft. by 4 ft., rather unnecessarily large, and this means that the ladder must also be 4 ft. wide! Surely this must be a mistake? Another obvious defect is that the *machan* must always be tied at the same height. Those who have tied many *machans* must know that it is often impossible to tie one at a given height owing to the shape of the only available tree, and that it has often to be tied higher or lower than the ideal. So far, therefore, from the *machan* being easily put up against any tree, as the author claims, it would seem that it might frequently be impossible to use it at all, no height is mentioned for the ladder, which is a pity from the novice's point of view.

If the *shikari* has no *machan* of his own he is advised to use an ordinary village charpoy—it is a pity that no explanation is given as to why four thin poles are required for tying this—personally I have never found them necessary or seen them used.

The author's advice on where to aim at dangerous game and his statements as to the results of different shots are in many cases sound, but in others are open to criticism. That " most rifles are sighted for the aim to be taken at the bottom of the target" is most certainly not true. They are sighted to hit the point aimed at. Again—"a shot directly beneath the root of the tail taken from behind is fatal". Yes, but this is dangerous advice if it leads to shots being taken at disappearing tigers. That " a shot in the lungs is fatal after the animal has gone 100 yards or so" is also misleading, as a tiger so hit may go considerably further and may live and show fight for at least an hour. The advice to fire " right into or behind the shoulder of a tiger, and if your aim is correct you will either smash his shoulder or get him in the lungs or heart" is, I think, not very sound. The danger of firing into the shoulder is that you may do nothing else but smash his shoulder, and thus give yourself much subsequent trouble unless you can get a fatal shot in at once with your second barrel. It is

safer to try behind the shoulder every time. Similarly to "aim at a charging tiger's chin or chest (if visible), and you will probably get him in the mouth" seems doubtful advice. A bullet in the mouth or chest may *do nothing more than bury itself in the* muscles of the chest and forearm unless the tiger is charging downhill. If he is charging on level ground or uphill a shot between or just above the eyes is probably best, and should get the brain, which is the best place to aim at hitting. Such a shot is said by some to be liable to glance off the skull, but I do not think this is likely to happen if it is fairly central, and I have seen one lay out a charging tiger very effectively.

With regard to the vexed question of the best armoury for game shooting the author rightly insists on a large bore rifle, preferably double barrelled, for dangerous game. A ·500 express firing low pressure cordite is mentioned as being nearly as good for tiger shooting as a large bore high velocity double barrel. In the opinion of several great authorities (and also from my own experience) this, or better still a ·577 express, is as good, if not better. It is a pity that the excellence of these rifles has not been more stressed, especially as they can be bought second-hand quite cheaply, and are thus within reach of the man of limited means.

D. D.

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NOTES ON SHEEP GRAZING IN CONIFEROUS FORESTS.

BY N. G. PRING, I.F.S.

Sheep in the Punjab and N.W.F.P. must be classified, for practical purposes, under two heads; those owned by nomads whose flocks are their sole means of livelihood and those owned by the farming population. The former are found mixed with goats and this combination is a serious menace to conservancy. Zones of utter barrenness indicate annual migrations between their summer and winter ranges, especially noticeable in a stretch of country in the N.W.F.P., bordering the Murree Hills and certain low hill tracts on the left bank of the Indus below Torbela.

On the other hand, sheep owned by the farming community are an entirely different proposition. A few sheep are certainly a great asset to the farmer and, unlike the local goats, whose wandering habits and catholic taste make them a scourge to the forester, sheep have very little aptitude for straying. Goats appear to prefer browsing to grazing, whereas sheep prefer grazing to browsing.

The following observations on sheep in coniferous forests may be of interest:—

Rawalpindi.—In June, 1927, owing to a plague of locusts, several flocks of sheep were driven from the Ling valley to the Kamra and Leh valleys *en route* for Murree where there is a

constant market. Their route lay largely through pure *chir* (*Pinus longifolia*) forests. The sheep were in a partially starved condition and relished the grass along the right of way, but no damage to *chir* was noticeable. One flock grazed on a boundary line between Government and *guzara* forests for about three days before being driven to water. No damage was done to *chir* seedlings, although grass was grazed right down and the fairly abundant bush growth (*Berberis Lycium*, *Myrsine africana* and *Rubus* spp.) was well browsed.

Hazara.—In January, 1930, nine sheep were put into the Batrasi block of forests, which contains nearly 900 acres of pure *chir* (P.B.I. area), during departmental burning operations. These sheep were allowed to wander through an area containing seedlings and saplings from 1 foot to 6 feet high. The crop had previously been well thinned, to varying espacements of 3 ft. to 5 ft. to allow controlled firing. The undergrowth consisted of a little rather dry grass, plantains, *Indigofera pulchella*, barberry and *Rubus* spp. The sheep grazed the tufts of grass at the base of the seedlings, at the same time avoiding the pine needles. They also grazed a fair proportion of the herbs and relished the bush growth. No damage was done to the *chir*, and the areas grazed were certainly easier to burn after grazing than before. Six sheep were allowed to graze near the Batrasi pass, on a very steep ridge with a southern aspect which contained a very open overwood of *chir* patches of regeneration less than six inches high, grass and bushes. At that time the ground was fairly dry and the object of the experiment was to note the damage done by trampling. No seedlings suffered either by trampling or browsing. Some damage to seedlings of less than a year old might, however, be expected during the wet monsoon when the animals' hooves would make much more impression. The third test consisted of confining two sheep for eight hours in an area of approximately 50 square yards near Batrasi Rest House. This plot contained 8 *chir* seedlings from 6 to 18 inches in height, pine needles, a little very poor grass, a small *Zizyphus Jujuba*, two small bushes of *Rubus* and leaves from *Pistacia integerrima*. At the end of the day it was observed that the *chir* had not been damaged though everything

else had been eaten. The sheep were still obviously hungry and were then given a mixture of *Indigofera*, grass and *chir* loppings. The grass and *Indigofera* were taken greedily and the *chir* left. A third sheep, which had not been fed that day, was offered lopped *chir*. This it refused. It was then offered *chir* and *Indigofera* intertwined and the *chir* was not touched. The owners were positive that sheep would not eat either *chir* or *kail* (*Pinus excelsa*). This assertion was borne out by two small tests made during April, 1930, in Thandiani Division, one near Biran Gali and the other between Kala Pani and Thandiani in pure *kail* P. B. II areas. In each case four local sheep grazed over areas containing *kail* regeneration, grass and a few bushes. Observations showed that no *kail* seedlings were touched, in the second case the sheep were kept for some time in the seedling area after they had finished all available grass.

Kulu.—In May, 1931, four sheep were grazed in Kasol Forest among fully stocked areas containing seedlings of deodar (*Cedrus Deodara*) *kail* and *chir* six inches and upwards in height, grass, herbaceous flora and bush growth of types such as *Indigofera Desmodium* and *Spiræa*. Observations were as follows :—The forage and leguminous plants were obviously preferred, but an occasional deodar was also browsed. The leading shoots of seedlings of 2 ft. high and under were taken and side shoots of young saplings. *Kail* and *chir* were not browsed and the sheep could not be coaxed to take them. Further observations were made from four tests carried out in the P. B. I areas above Pulga which contain deodar, *kail*, silver fir (*Abies Pindrow*), spruce (*Picea Smithiana*) and a little yew (*Taxus baccata*) regeneration in mixtures of various proportions. These observations showed that not only deodar, but silver fir, yew and spruce are liable to sheep browsing, even where forage is abundant. A few of the lowest needles of a *kail* sapling, over four feet in height, were pulled off together with the grass which had overgrown them, in no other case was any damage to *kail* observed.

A small flock of seven sheep, which had been put on to a homestead field near Jarri, was given loppings of olive (*Olea*

glandulifera), *kail*, deodar and cypress (*Cupressus torulosa*). All except the *kail* were eaten. After coaxing, one ewe was persuaded to accept *kail*, but one mouthful was sufficient to make her drop the branch. Similar tests made in the Parbatti and Beas valleys during May and June proved that a very small percentage of sheep could be coaxed to accept *kail* loppings and these dropped them almost immediately. During June personal observation of sheep grazing in Lower Sesni, Naggar Jhir and Kaloint, all of which are P. B. I. areas containing deodar, *kail* and spruce regeneration, show that the damage to *kail* was nil. A short test was made late in June over a small area containing *kail* seedlings of less than 2 years and up in Khoruthach Forest (Parbatti valley) to note the damage by trampling; a flock of six sheep bunching over *kail* seedlings of less than two years old did no damage, *Spiraea Lindleyana*, *Salvia glutinosa* and grass were relished but neither *kail* nor spruce were touched.

From the above observations it may be concluded that among the more common conifers of the Punjab and Frontier only *chir* and *kail* are unpalatable to sheep and that damage from trampling among seedlings of over one year old is negligible. The observations were of necessity based on insufficient data to prove that sheep* never browse *chir* or *kail*, but even assuming such to be the case, the benefit accruing from the cropping of weeds in stands of coniferous regeneration would be offset by the sacrifice of broad leaved species. On the other hand, as a special concession in times of drought or famine, the grazing of sheep in areas too steep or distant from water for cattle grazing would prove a great boon to the local inhabitants and would considerably diminish the risk of fires.

This article is written to the end that controlled sheep grazing should be inaugurated as an experiment on fire lines within the *chir* and the lower *kail* zones. No forester will contest the value of a well kept fire line but the difficulty of keeping fire lines clear probably accounts for this paucity in the Punjab and

*Starving cattle will eat *chir* and *kail*, most probably starving sheep would eat them where nothing else was available.

N. W. F. Province. In the pure *chir* zone fire lines can be burnt under control but the burnt bush growth together with long grass increases rather than decreases the fire hazard, and a fire line in the *kail* zone could not be burnt without the greatest difficulty and risk. Since fire lines are most necessary in the drier areas where cattle grazing is often precluded by the distance from water, there is no reason why combined cattle and sheep grazing should not be indulged in wherever possible. A very attractive proposition is the introduction or the encouragement of leguminales such as clovers, lucerne, vetches, etc. Besides producing mutton, wool, skins and occasionally milk, sheep are used extensively for manuring purposes.

NAME CHANGES IN IMPORTANT INDIAN TREES.

BY R. N. PARKER, I.F.S.

As the familiar names of a great number of well-known Indian trees have recently been changed, silviculturists, research officers and others are finding difficulty in filing information. I have, therefore, been asked to make out a list showing recent changes. In doing so I find that, if some of the changes proposed are accepted and some are in my opinion desirable whereas others are inevitable, a few additional changes result. In making out this list I started trying to exclude everything in the way of a recommendation as to which name should be employed, but the introduction of some of the unfamiliar names seems so undesirable, though at first sight they may appear to be correct under the rules of botanical nomenclature or have been adopted probably without any independent investigation, that I have added a few notes in explanation. In all cases the name first mentioned is the one which, as at present advised, I consider correct under the rules or the one which I personally should prefer. I do not go so far as to advise anyone else to accept these names. If there is a recent local flora for a province it will probably be most convenient to follow the nomenclature adopted therein. In other cases the best name to adopt is the one most likely to be used in the references that it is

wished to collect. All questions of Taxonomy have been avoided as far as possible and the alternative names quoted without comment are, I believe, simple synonyms, provided always that the earlier synonymy is correct. For example I have not usually gone into such questions as whether *Carallia lucida* Roxb. and *C. integerrima* DC. are synonymous or not or whether *Diatoma brachiata* Lour is actually the same plant.

Michelia Baillonii Finet and Gagnep. *Talauma spongocarpa* King and *T. phellocarpa* King.

Bambax malabaricum DC. *B. Ceiba* Linn. The latter name appears to be correct under the rules and has been adopted in several recent works. Bakhuizen van den Brink, however, considers *Bombax* an American genus and calls this tree *Gossampinus heptaphylla* (Houtt.) Bakh.

Ceiba pentandra Linn. *Eriodendron anfractuosum* DC.
Berria cordifolia (Willd.) Burret. *B. ammonilla* Roxb.
Limonia crenulata Roxb. *L. acidissima* Auct. non Linn.
Feronia elephantum Corr. *F. Limonia* (Linn.) Swingle.
Protium serratum Engl. *Bursera serrata* Roxb.

Aphanamixis polystachya (Wall.) Comb. nova. The oldest name for this tree is *Aglaia polystachya* Wall. in Roxb. Fl. Ind. II (1824) p. 429. In the genus *Amoora* the name *A. polystachya* (Wall.) Hook. f. & Jackson takes precedence over *A. rohituka* W. & A. In my opinion, however, the genus *Aphanamixis* Bl. should be recognized but the name *Aphanamixis rohituka* Pierre cannot be retained.

Xylocarpus moluccensis Roem. *Carapa moluccensis* Lamk.

Xylocarpus obovatus A. Juss. *Carapa obovata* Bl. *Xylocarpus granatum* Koenig is an older name but it has frequently been used erroneously in place of *X. moluccensis* and if retained is liable to cause confusion.

Schleichera oleosa (Lour.) Merr. *S. trijuga* Willd. There seems little doubt that *Pistacia oleosa* Lour. is the tree so long known as *S. trijuga* Willd.

Lannea grandis Engl. *Odina Wodier* Roxb.

Spondias pinnata (Linn. f.) Kurz. *S. mangifera* Willd.

Swintonia floribunda Griff. *S. Schwenkii* Teysm. & Binn ex Kurz.

Buchanania lanzan Spreng. *B. latifolia* Roxb.

Moringa oleifera Lamk. *M. pterygosperma* Gaertn.

Pongamia pinnata (Linn.) Merr. *P. glabra* Vent.

Erythrina indica Lamk. *E. variegata* Linn. The latter name is earlier but being based on a "monstrosity" has to be rejected.

Peltophorum inerme (Roxb.) Llanos. *P. ferrugineum* Benth.

Delonix regia Rafin. *Poinciana regia* Boj.

Albizzia stipulata Boiv. *A. chinensis* Merr. *A. marginata* Merr. I do not think it advisable to give up the familiar name *A. stipulata* Boiv. until the taxonomic questions involved have been satisfactorily settled in a monograph of the whole genus.

Prunus cerasoides D. Don. *P. Puddum* Roxb.

Ceriops tagal C. B. Rob. *C. Candolleana* Arn.

Rhizophora candelaria DC. *R. conjugata* Auct. plur. non Linn.

Bruguiera gymnorhiza Lamk. *B. conjugata* Merr. Linnaeus under *Rhizophora* has five species the first being *R. conjugata* and the second *R. gymnorhiza*. Merrill says:—"If we follow the rules of nomenclature, as to priority, the acceptance of the Linnean specific name *conjugata* for this species is unavoidable, although it has only place priority over *R. gymnorhiza* in the original publication". Priority of this nature is not recognized under the International Rules of Botanical Nomenclature. On the contrary, names of the same date are regarded as of equal standing irrespective of place or page priority. There is, therefore, no reason to give up the name *B. gymnorhiza* Lamk, which has been in use for 130 years.

Bruguiera cylindrica (Linn.) Bl. *B. caryophylloides* Bl.

Bruguiera sexangula (Lour.) Poir. *B. eriopetala* W. & A.

Carallia brachiata (Lour.) Merr. *C. integerrima* DC. *C. lucida* Roxb.

Terminalia tomentosa W. & A. *T. alata* Heyne. The latter name is earlier. *T. tomentosa,* however, as at present understood, embraces a number of forms or even species the status of which requires to be settled first. If it is decided to split up the group into say 5 species it will be necessary to determine to which the name *T. alata* Heyne relates and *T. tomentosa* W. & A. may remain the valid name for one of the segregates.

Eugenia sensu lato and *Eugenia sensu stricto, Syzygium* and *Jambosa.* It would be of distinct advantage if the enormous genus *Eugenia* could be broken up satisfactorily. Some authors recognize *Syzygium* and *Jambosa* as distinct genera but this is not universal and frequently they are not even used as sections of the genus.

Eugenia cumini (Linn.) Druce. *E. jambolana* Lamk. and *Syzygium jambolanum* DC.

Lagerstroemia speciosa (Linn.) Pers. *L. Flos-Reginae* Retz.

Sonneratia caseolaris Engl. *S. acida* Linn. f. Merrill in Interp. Rumph. Herb. Amboin. uses *S. caseolaris* (Linn.) Engl. in the above sense but in Enum. Philip. Flow. Pl. he uses *S. caseolaris* (Linn.) Engl. as synonymous with *S. alba* Sm. Linnaeus based his *Rhizophora caseolaris* on three plates of Rumphius. The first person (after Rumphius) to separate this plant into two species was Smith who chose the plant represented by t. 73 as the type of his species *S. alba* Sm. and left the plant represented in plates 74 and 75 under *Rhizophora caseolaris* Linn. This arrangement cannot be changed now quite apart from the fact that Smith's action was correct under the present rules. Merrill's later views in Enum. Philip. Flow. Pl. seem to be based on a mistaken idea of the importance of page priority. Merrill to be consistent should take *Rhizophora conjugata* Linn. (the first species mentioned) as the type of *Rhizophora* if he insists that t. 73 must be the type of *R. caseolaris* Linn. because it is the first of 3 plates mentioned.

Anthocephalus cadamba (Roxb.) Miq. *A. indicus* A. Rich.

Mitragyna Korth. (1839). *Stephegyne* Korth. (1840).

Mitragyna rotundifolia (Roxb.) O. Kuntze. *Stephegyne diversifolia* Hook. f.

Nauclea Linn. This is taken by Merrill to be synonymous with *Sarcocephalus* Afzelius. *Nauclea* as hitherto understood is renamed *Neonauclea* Merrill. If this is accepted, as it has been in Gamble's Flora of Madras the following changes result:—

Sarcocephalus missionis Haviland becomes *Nauclea missionis* W. & A. and *Nauclea purpurea* Roxb. becomes *Neonauclea purpurea* (Roxb.) Merrill.

Bassia Koenig (1771) is invalidated by *Bassia* Allioni (1766) a genus of the *Chenopodiaceæ*. All the trees hitherto known as *Bassia* have to be transferred to *Madhuca* Gmelin. The important species are:—

Madhuca latifolia (Roxb.) Macbride.

Madhuca longifolia (Linn.) Macbride.

Madhuca butyracea (Roxb.) Macbride.

Madhuca malabarica (Bedd.) comb. nov.

Manilkara Adans. This genus is recognized by Lecomte in Fl. Gen. Indo-Chine as distinct from *Mimusops*. The genus *Mimusops* as accepted by Engler in Pflanzenfamilien is a heterogeneous collection of forms of wide distribution. The original genus of Linnaeus contained only two species of which *Mimusops elengi* Linn. is the type. *Manilkara* is a genus of Rheede Hort. Mal. 4, t. 25. This is *Mimusops indica* A. DC. usually reduced to *Manilkara hexandra* (Roxb.) Lecomte. Two more transfers have to be made:—

Manilkara Roxburghiana (Wight) comb. nov.

Manilkara littoralis (Kurz) comb. nov.

The two genera are distinguished as follows:—

Flowers normally tetramerous; seed with a small sub-basal nearly circular hilum ... ... *Mimusops*.

Flowers normally trimerous; seed with a sublateral linear hilum many times longer than broad ... *Manilkara*.

[I have not been able to check the seed character in the case of *Manilkara Roxburghiana* but it is shown in Wight's figure.]

Donella Roxburghii (G. Don) Pierre. *Chrysophyllum Roxburghii* G. Don. This results from the restriction of *Chrysophyllum* to New World species.

Diospyros buxifolia (Bl.) Hiern *Diospyros microphylla* Bedd.

Cerbera manghas Linn. *C. odollam* Gaertn.

Cordia dichotoma Forst. Hutchinson in Kew Bull. 1918 p. 221 considers that the Indian tree hitherto known as *Coridia Myxa* Linn. should be called *C. obliqua* Willd. In this he has been very generally followed. *C. dichotoma* Forst. is an older name for *C. obliqua* Willd.

Haplophragma adenophyllum P. Dop. *Heterophragma adenophyllum* Seem. Dop creates a new genus for this tree and excludes it from *Heterophragma* owing to the dissepiment being winged in such a way as to make the fruit 4-locular.

Emblica officinalis Gaertn. *Phyllanthus Emblica* Linn.

Artocarpus integra Merrill *A. integrifolia* Linn. f.

Morus acidosa Griff. *M. indica* Auct. non Linn. *Morus indica* Linn. is a synonym of *M. alba* Linn. The name *M. indica* has usually been used for a tree the correct name for which is *M. acidosa* Griff.

Quercus. This genus is now often divided into *Quercus* and *Pasania.* For the latter *Lithocarpus* an earlier name is sometimes substituted but these two are not always considered strictly synonymous.

Arenga pinnata (Wurmb.) Merrill. *A. saccharifera* Lab.

Pinus insularis Endl. *P. kesiya* Royle, more often written *P. khasya.* As it is not quite certain that *P. khasya* and *P. insularis* are identical the name *P. khasya* should be retained.

Picea Smithiana Boiss. *P. morinda* Link.

Picea spinulosa Beissn. *P. morindoides* Rehd.

Podocarpus latifolius Wall. *P. Wallichianus* C. Presl. The latter name is correct under the rules.

DEHRA DUN,

8th August, 1931.

THE BAMBOO FORESTS OF HOSHIARPUR DISTRICT, PUNJAB.

By M. Fateh Mohammad, P.F.S.

Nature has adorned the extreme western end of the Siwalik hills with pure bamboo (*Dendrocalamus strictus*) forest over an area of 6,570 acres. These hills separate the fertile plains of Dasuya Tehsil of the Hoshiarpur district from the riverine tracts lying along the Beas river. The height of these hills varies from 1,478 to 2,172 feet. The average rainfall, from the previous two years' records, is 67·17 inches. This western end of the Siwalik beds is overlaid by gravels, probably of riverine origin, and is divided by *nalas* into two compact blocks called Karnpur, with an area of 3,598 acres parallel to the Mukerian-Talwara District Board Road on the left bank of the Beas river, and Bindraban, with an area of 2,972 acres about five miles to the west of Karnpur.

These forests were inherited by the British Government from the Sikhs as State forests, and, in common with a portion of the pine forests of Hoshiarpur district, were demarcated about the year 1848-49 at the time of the first settlement. Until 1866 these forests were managed by the District Officers under special rules, which provided for the division of the forests into three parts, one of which was to be kept always closed, and for the grant to the *zamindars* of one-fourth of the income derived from them. On 1st May, 1866, the forests mentioned above, together with some other undemarcated areas, were made over to the charge of the Forest Department, and shortly after the transfer difficulties were experienced with the people. In consequence, the Conservator of Forests, Punjab, represented to Government in 1869 that management under the rules framed by the District authorities was impracticable and suggested that a certain portion should be constituted the absolute property of Government and that Government in return should give up, or considerably modify, its rights in other tracts. These proposals were accepted and work was started in 1870. It resulted in the demarcation of an area of 10,813 acres, which, along with the bamboo forests of Karnpur and Bindraban, were gazetted as reserved forests

in March, 1879, when the following rights of villagers were admitted :—

I.—RIGHTS OF VILLAGERS.

There are numerous rights of villagers in both Karnpur and Bindraban forests. In the former one-half of the forest was open to the grazing of the cattle of 16 villages throughout the year except for three months of the rains, (July, August and September) when the whole forest was closed; the inhabitants of these villages were also allowed to take firewood from the open portions, and were entitled to receive bamboos for their own use on payment of the cost of cutting and carriage to Forest Depôts. Similar rights were exercised in Bindraban reserve forest by 16 villages, only in this forest the portion closed throughout the year amounted to two-thirds of the whole. In addition to these recorded rights, the people were accustomed to lop the bamboos for fodder. This practice was the cause of much damage, and to a larger extent of the congested condition of the clumps, for shoots, the top of which had been cut for fodder, were useless for sale and were left to gradually die down and choke the clumps. On the other hand the system of partial closure was a considerable hardship to the villagers situated on the side of the forests furthest removed from the portion open at any given time. It was, therefore, recognised that the system required modification and proposals were made to the Deputy Commissioner of Hoshiarpur in 1903 that lopping should be put a stop to, and, in return, that the forests should be opened throughout the year, with the exception of the three monsoon months and the closure, when necessary, of small areas which it was desired to restock artificially. This arrangement which had been agreed to by the Deputy Commissioner on behalf of the people and sanctioned by the Conservator is in force at the present time.

In fact, all these rights in their original form were admitted when there were only a few hundred cattle grazing in each of these forests and when the present 32 villages were only small hamlets and the forests, as is generally believed, so dense that cattle could hardly find their way to graze through them. But

with the increase of population in these hamlets, which have now grown to big villages, the number of cattle has increased to thousands and the demand of the villagers for grazing and fire wood has increased enormously to an extent which the forests cannot afford. The result is deterioration and denudation everywhere along the boundaries close to habitation.

II.—IMPROVEMENT OF THE CONDITION OF THE FORESTS.

Closing the above brief description of the rights of the people in these forests, I now turn to discuss the system of working in them and, before doing so, I would like to describe some salient points in connection with the improvement of their condition.

Apart from the exercise of excessive rights the Forest Department has also been responsible for bringing the forests to their present condition by carrying out heavy fellings to meet military and local demands during, and for a few years after, the Great War.

The following statement shows the fluctuation in operations since 1909 :—

Year.	Karnpur Reserved Forest.			Bindraban Reserved Forest.			Total of both forests.
	Main fellings.	Fellings for Right-holders.	Total.	Main fellings.	Fellings for Right-holders.	Total.	
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
1909-10 ...	1,64,422	..	1,64,422	3,24,544	...	3,24 544	4,88,966
1910-11 ...	2,44,185	...	2,44,185	1,28,528	...	1,28,528	3,72,713
1911-12 ...	5,43,631	...	5,43,631	1,10,983	...	1,10,983	6,54,614
1912-13 ...	2,20,055	...	2,20,055	2,26,167	...	2,26,167	4,46,222
1913-14 ...	4,16,820	...	4,16,820	6,342	...	6,342	4,23,162
1914-15 ...	2,11,630	...	2,11,630	397	...	397	2,12,027
1915-16 ...	3,50,315	...	3,50,315	2,13,108	...	2,13,108	5,63,423
1916-17 ...	6,27,635	...	6,27,635	346	...	346	6,27,981
1917-18 ...	8,01,683	...	8,01,683	3,43,320	...	3,43,320	11,45,003
1918-19 ...	11,03,837	...	11,03,837	1,25,230	...	1,25,230	12,29,067
1919-20 ...	6,02,268	9,650	6,11,918	2,57,552	10,820	2,68,372	8,80,290
1920-21 ...	4,89,203	1,800	4,91,003	1,89,350	8,825	1,98,175	6,89,175

1921-22	...	3,13,507	11,133	3,24,640	2,04,505	10,400	2,14,905	5,39,545
1922-23	...	3,57,773	5,300	3,63,073	3,18,960	7,550	3,26,510	6,89,583
1923-24	...	2,56,374	9,500	2,65,874	2,73,065	10,250	2,83,315	5,49,189
1924-25	...	2,35,145	4,000	2,39,145	2,94,730	3,600	2,98,330	5,37,475
1925-26	...	3,08,564	3,400	3,11,964	2,51,603	3,300	2,54,903	5,66,867
1926-27	...	2,96,929	4,000	3,00,929	2,11,450	5,850	2,17,300	5,18,229
1927-28	...	1,07,103	11,900	1,19,003	78,065	14,200	92,265	2,11,268
1928-29	...	1,38,909	13,600	1,52,509	95,630	6,850	1,02,480	2,54,989
1929-30	...	1,14,904	15,330	1,30,234	1,15,515	15,825	1,31,340	2,61,574
1930-31	...	85,345	5,310	90,655	94,480	7,900	1,02,380	1,93,035

These figures are in themselves conclusive proof of the heavy demand which could not have been met without carrying out heavy fellings. Thus, the exercise of numerous rights by the villagers in the edges of the forests close to their homes and heavy fellings, combined with heavy grazing, have certainly resulted in the deterioration of these forests.

These forests are a very valuable property consisting of pure bamboo, most of which are solid and are the only examples of such forests in the Punjab.

In order, therefore, to improve their condition the following methods have been adopted :—

(*a*) Small fenced closures are laid out every year on the fringes, where the exercise of rights by the villagers is excessive, and are regenerated artificially.

(*b*) Cleanings in congested clumps are carried out over a minimum area of 200 acres, followed by the main fellings.

(*c*) Annual fellings are made strictly in accordance with the silvicultural rules in the bigger clumps only which yield marketable produce.

(a) *Artificial regeneration in small fenced closures.*

As already explained, deterioration and denudation have been taking place on the edges close to the villages. In 1919 the Forest Department began to lay out small fenced areas to obtain bamboo regeneration and to stop denudation.

Cultural works were started by direct sowings and the planting of rhizomes. These closures were extended over 41 acres during the succeeding eight years at a cost of Rs. 768, but no success was attained. Then in the year 1928-29 direct sowings of all kinds and offset planting were abandoned and a small bamboo nursery was prepared in a suitable locality in the middle of Bindraban Forest with the object of raising bamboo seedlings for planting out in the blanks. Ever since then the old closures and new extensions are being filled from the nursery by

transplanting under the shade of bushes which provide shade from the southern and eastern sides. Nearly 50 per cent. of the seedlings so far transplanted survive, but the blanks are extensive and will take years to restock.

(b) *Cleaning congested clumps.*

The second method adopted for the improvement of these forests is the cleaning of congested clumps, followed by silvicultural fellings.

This operation aims at removing the congestion of clumps, which have been badly injured by the exercise of excessive rights or by injudicious fellings in the past. This is done by removing all dead, crooked and malformed bamboos without touching any green bamboos growing along the periphery of the clump. In certain cases even dead and crooked bamboos are left standing to give support to the new as well as the old shoots. The cleaning operation precedes the main fellings, as the congested clumps are thus rendered accessible to the fellers and they are enabled to do their work strictly in accordance with the felling rules.

In carrying out these cleanings strict supervision over each clump is essential so as to avoid mistakes in the extent of cleaning and to see that no clump requiring cleaning is missed.

From the records available it appears that the operation of cleaning was started simultaneously with the departmental fellings in 1917, but, in doing so, no distinction was ever made between a silvicultural cleaning and silvicultural felling, nor was any permanent record kept to show that areas had been cleaned.

To achieve the main objects of the operation a regular series of annual cleanings over a minimum area of 200 acres was arranged from the year 1926-27, followed by regular annual fellings. Ever since then, apart from clearing the previous year's arrears, which were 345 acres, the new arrangements

are being strictly adhered to and the following areas have been cleaned :—

Year of cleaning.	Area cleaned in acres.	No. of clumps cleaned.	Cost of the year.	Average cost per acre.
			Rs.	Rs. a. p.
1926-27 ...	113·15	4,413	1,069	9 7 4
1927-28 ...	241·00	6,037	1,000	4 2 4
1928-29 ...	559·07	16,092	1,349	2 6 8
1929-30 ...	216·85	10,283	650	3 0 0
1930-31 ...	214·56	12,506	748	3 8 0
Total ...	1,344·63	49,331	4,816	3 9 4

The results of these cleanings followed by silvicultural fellings have been marvellous. It may be mentioned here that the monsoon rains are mostly responsible for a good bamboo yield, but, so long as there is congestion in the clumps, any amount of rain has no effect on the production of healthy and straight bamboos. As a matter of fact, the areas so far cleaned present the appearance of ideal forest well stocked with new bamboo shoots, which, in most healthy clumps, are produced at the rate of from 20 to 30 a year. With such improvement in the growth of the clumps, which is more conspicuous in Karnpur Forest, the sizes of new shoots are also improving and many clumps, which would have otherwise produced bamboos of the inferior classes, are now producing better bamboos so that systematic cleanings are tending to increase considerably the value of the forests.

(c) *Bamboo explotiation.*

For financial, commercial and silvicultural reasons this is the most important part of my subject and before I deal with all its stages, I would like to mention here that for two consecutive years experiments were made to determine the most suitable period at which to cut so as to minimise damage from borers. For this purpose the first experiment was started in October, 1927, when 56 bamboos belonging to eight different

classes, *viz.*, *Salam Kalan*, *Patti Kalan*, *Patti Khurd*, *Chhar*, *Majhola*, *Mandhaoo*, *Sota Kalan*, and *Sota Khurd* were felled and kept in separate lots. Fellings were repeated every fortnight till 16th May, 1928, and all bamboos were under observation upto 30th June, 1928, *i.e.*, upto the break of the monsoon. The experiment was repeated on the same lines from October, 1928, till the end of June, 1929. At both times all the bamboos were kept in the same locality to ensure identical conditions. All the bamboos were inspected daily and the results of observations recorded. Along with the investigation of insect attacks, the opportunity was taken to find the amount of shrinkage by taking weekly girth measurements. The bamboos were generally felled from healthy uncongested clumps, and no bamboo, which showed any insect attack at the time of felling, was included in the experiment. Interesting figures were obtained with regard to shrinkage and insect attack. It was noticed that shrinkage varied from $\frac{1}{4}''$ to $1''$ and that with regard to insect attack the safest time for cutting was the month of May. But fellings cannot be made during the summer on account of the scarcity of labour and of water in the forests, and the unwillingness of the purchasers to buy bamboos on account of the impending rains and also the fire hazard owing to work being carried out at this season.

The second best month is December. Felling at the end of October, November and the beginning of January give fairly good results. The worst period for fellings begins at the end of January and lasts till the end of April. It, therefore, follows that felling operations should begin towards the end of October at the earliest and cease by the middle of January. The existing practice of carrying out fellings conforms to this conclusion.

CUTTING CYCLE.

At present the forests are being worked on a two years' cutting cycle. Experience has shown that bamboos less than three years old are immature and the market will not have them. On comparing data collected from the records of sample plots laid out in Karnpur Forest to determine the felling rotation of bamboos, it is evident that the production of superior classes of bamboos is

5·79 under two years' rotation and 13·27 under three years' rotation. Both these factors combined with the gradual fall in demand are sufficiently sound reasons for reducing the present working areas and increasing the cutting cycle from 2 to 3 years.

FELLINGS.

Usually bamboo fellings commence every year in the last week of October and last till the end of the third week of January. These fellings are made in congested clumps after they have been cleaned, and from uncongested clumps in the ordinary course. Saleable material is extracted according to the following prescribed silvicultural rules :—

(*i*) All bamboos are cut within one foot from the ground.

(*ii*) No portion of the cut shoots is left in the clump.

(*iii*) No *chhal* (leading exterior shoot) is cut and is left even if malformed, but otherwise malformed shoots only interfere with the cutting and should be got rid of as soon as possible.

(*iv*) Except for the purpose of binding bundles no shoot of the year or the year previous is cut, provided that, except as prohibited by (*iii*), malformed shoots are cut at any time.

(*v*) Except as prohibited above, any shoot may be removed provided (*a*) that sufficient are left to provide support for the young shoots and (*b*) that those that are left are evenly distributed over the rootstock, of which no part is to be clear-felled.

(*vi*) All flowered bamboos are removed from a clump whether they grow in the interior of the clump or on the periphery, as naturally the flowered bamboos die and there is no use in leaving them standing in the clump.

In carrying out these fellings every effort is made to spare small and open clumps which have already suffered from congestion and over-felling. The fellings are done on contract by trained labour under strict supervision by the Forest Staff.

Bamboo cutters are paid at the rates noted against each class according to which they can earn Re. 0-7-0 to Re. 0-8-0 a day.

The following is the standard classification of bamboos arrived at in consultation with the trade :—

Names of classes of bamboos.	Girth at the third internode.	Length.	Rate of felling per 100 including carriage to Forest Dépôts. Rs.	a.	p.	Remarks.
Salam Kalan I .	Over 6″	15′ to 18′	2	6	0	As straight and sound as possible and specially selected.
Salam Kalan II	Over 6″	15′ to 18′	2	6	0	Left behind after sorting I class.
Patti Kalan ...	5½″ to 6″	9′	1	10	0	Full size bamboos are extracted from the forest and are cut in the Forest Depôts into proper lengths. The tops are then classed separately.
Patti Khurd ...	5¼″ to 5½″	7′ to 8′	1	7	6	
Chhar I ...	4″ to 5″	22′ & over	1	8	0	
Chhar II ...	4″ to 5″	18′ to 21′—11″	1	0	0	
Majhola ...	4¼″ to 5¼″	14′ to 15′	0	15	6	
Mandhaoo ...	3¾″ to 4¼″	13′ to 14′	0	11	6	
Sota Kalan ...	3½″ to 3¾″	12′ to 12′—11″	0	9	0	
Sota Khurd ...	2″ to 3½″	5′ to 8′	0	4	0	

Apart from the above fixed wages, the department has to arrange for the daily supply of 10 to 16 tins of water for the fellers, at an average rate of Re. 0-1-6 per tin, on account of the scarcity of drinking water.

A mate is appointed on daily labour at 8 annas a day for three months for supplying workmen. He is held responsible for looking after the comfort of his coolies, for getting the daily out-turn counted, classified separately, stacked and entered in the registers by classes against the name of each coolie.

Forest Depot Work.

After the bamboos have been received in the Forest Depôts and entered in the daily registers, the classes of bamboos which are called *Patti Kalan* and *Patti Khurd* are cut into proper lengths of 9 feet and 7 to 8 feet respectively, at a fixed rate of Re. 0-2-0 per hundred. These *Pattis* and their tops are then sorted, classified according to their definitions, rebundled and restacked in the depôt by men on daily labour. Whatever hollow tops of flowered bamboos are sorted out are treated as *Saranchas* which are then clean dressed of knots at the rate of Re. 0-6-0 per hundred and stacked separately.

It may be mentioned here that the term *Sarancha* is an invention of chick-makers who use them for making chicks and that whatever *Saranchas* are thus extracted from these forests are generally sold to various jails in the Punjab where they are used in making door-chicks.

Carriage of Bamboos to the Sale Depot.

All the Forest Depôts are reached by cart roads, which ultimately join the Mukerian-Talwara District Board Road. The bamboos from the Forest Depôts are carried on carts at the following fixed rates by classes to Mukerian Sale Depôt under proper chalans issued by the Forest Depôt Officer. These carts are supplied by a contractor who gets an extra Re. 0-3-0 commission per cart. He is paid his carriage bills weekly and is held responsible for the direct payment to his cartmen and delivery at Mukerian Sale Depôt of the correct number of bamboos despatched from the Forest Depôts.

Carriage rates.

			Rs.	a.	p.	
Salam Kalan I	...	...	3	6	9	per hundred.
Salam Kalan II	...	...	2	14	9	do.
Patti Kalan	...	...	1	10	9	do.
Patti Khurd	...	...	1	2	9	do.
Chhar I & II	...	...	2	0	9	do.

		Rs.	a.	p.	
Majhola	... ...	2	0	9	per hundred.
Mandhaoo	... ...	1	2	9	do.
Sota Kalan	... ...	0	8	9	do.
Sota Khurd	... ...	0	2	9	do.
Tops I	... ...	0	10	9	do.
Tops II & Misc:	... ...	0	8	9	do.
Saranchas I & II	... ...	1	0	9	do.

The bamboos on arrival in the sale depôt are counted according to the chalans issued by the Forest Depôt Officer, entered in the daily receipt register, and stacked separately by classes by men on daily labour in lots of 200 to 1,000 to afford facilities to small purchasers. This finishes the whole process of the extraction of bamboos from the forests and their carriage to the sale depôt where they are finally auctioned.

DETAILS OF EXPENDITURE INCURRED DURING THE LAST FOUR YEARS ON BAMBOO EXPLOITATION WORKS.

The following table gives an accurate account of the various items of expenditure incurred during the last four years:—

Name of items.	Expenditure incurred during :— 1927—28.			1928—29.			1929—30.			1930—31.			Total.		
	Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.
Fellings paid to fellers	1,853	14	0	2,438	14	0	2,252	15	0	1,828	6	3	8,374	1	3
Mates' commission...	96	8	0	122	4	0	99	0	0	60	0	0	377	12	0
Cutting *pattis* into proper lengths	34	12	0	52	11	3	31	14	6	40	5	9	159	11	6
Dressing of *saronchas*	9	10	0	5	2	6	8	7	9	18	2	9	41	7	0
Bundling, sorting and stacking in Forest Depôts ...	96	0	0	135	12	0	74	8	0	89	8	0	395	12	0
Water supply to fellers	67	5	9	104	1	6	77	14	9	71	5	6	320	11	6
Rent of a Forest Depôt	8	12	0	8	2	3	8	0	0	8	0	0	32	14	3
Carriage of bamboos to Mukerian	3,143	0	0	4,132	0	0	3,944	8	0	3,289	0	0	14,508	8	0
Carriage contractor's commission	87	6	0	117	15	0	113	0	0	95	0	0	413	5	0
Stacking at Mukerian	226	12	0	220	3	6	189	0	0	142	5	0	778	4	6
Total ...	5,623	15	9	7,337	2	0	6,799	4	0	5,642	1	3	25,402	7	0

SALE OF BAMBOOS.

Prior to 1917 these forests were worked on a royalty system in return for an annual revenue of five to six thousand rupees, but in 1917 such sales were stopped and the department took over the exploitation. This was the time of the Great War when the demand for bamboos was at its height. Separate rates for the supply of bamboos to the Military Department and local traders were fixed. These rates varied from time to time with local conditions, but the following table gives an idea of the rates which prevailed till 1926-27 :—

	Rs.	a.	p.	
Salam Kalan	27	0	0	per hundred.
Patti Kalan	10	8	0	do.
Patti Khurd	8	2	0	do.
Chhar I	15	0	0	do.
Chhar II	8	8	0	do.
Majhola	6	0	0	do.
Mandhaoo	5	0	0	do.
Sota Kalan	5	0	0	do.
Sota Khurd	4	0	0	do.
Tops I	3	8	0	do.
Tops II & Misc.	2	4	0	do.
Saranchas I	8	12	0	do.
Saranchas II	7	12	0	do.

After 1926-27 sales at fixed rates were entirely stopped and the system of sale by public auction was introduced. The first year's sales were satisfactory as is shown from the attached statement, but subsequently prices gradually decreased along with the depression in all markets and the trade at the present moment is confined to only a few members of one community who live from hand to mouth.

The following statement gives an accurate account of revenue realised from the sales of the various classes of bamboos and the net profit derived during the last four years :—

Statement showing revenue realised from the

Class of bamboos.	1927-28.							1928-29.						
	No. of bamboos sold.	Sale price.			Average per 100.			No. of bamboos sold.	Sale price.			Average per 100.		
		Rs.	a.	p.	Rs.	a.	p.		Rs.	a.	p.	Rs.	a.	p.
Salam Kalan	519	157	0	0	30	3	1	184	31	0	0	16	13	7
Patti Kalan ...	2856	479	0	0	16	12	5	1263	203	0	0	16	0	9
Patti Khurd..	25143	2,998	0	0	11	14	8	42385	4,003	0	0	9	7	1
Majhola I ...	91439	6,326	0	0	6	14	8	134418	9,413	8	0	7	0	3
Mandhaoo ...	37348	2,973	1	0	7	15	5	42568	3,018	12	0	7	1	5
Chhar I ..	1095	337	0	0	30	12	10	20	0	8	0	2	8	0
Chhar II ...	10065	1,706	0	0	16	15	2	3522	510	0	0	14	7	0
Sota Kalan ...	12910	660	0	0	5	1	9	13282	722	12	0	5	7	1
Sota Khurd ...	238	10	0	0	4	3	3	116	1	0	0	0	13	9
Sarancha I ...	450	39	6	0	8	12	0	510	44	10	0	8	12	0
Sarancha II ...	965	74	12	7	7	12	0	870	67	6	10	7	12	0
Tops I ...	6840	438	0	0	6	6	10	7700	466	0	0	6	0	10
Tops II ...	12873	444	0	0	3	4	6	18735	704	0	0	3	12	1
Tops misc. ...	4210	83	0	0	1	15	6	8230	180	8	0	2	3	0
Total ...	206951	16,725	3	7	8	1	3	273803	19,366	0	10	7	1	2
Expenditure ...		5,623	15	9	2	12	0		7,337	2	0	2	10	10
Surplus ...		11,101	3	10	5	5	3		12,028	14	10	4	6	4

sale of bamboos during the last four years.

1929-30.										1930-31.									
No. of bamboos sold.	Sale price.			Average per 100.						No. of bamboos sold.	Sale price.			Average per 100.					
	Rs.	a.	p.	Rs.	a.	p.					Rs.	a.	p.	Rs.	a.	p.			
430	107	0	0	24	14	2				185	40	0	0	21	10	0			
7635	1,037	0	0	13	9	3				3420	385	4	0	11	4	1			
18175	2,166	12	0	11	15	0				28860	2,185	0	0	7	9	2			
126311	7,680	0	0	6	1	3				110440	5,624	0	0	5	1	6			
37135	1,443	12	9	3	14	3				12260	402	12	0	3	4	7			
2980	628	0	0	21	1	8				1790	270	0	0	15	1	4			
11395	1,254	0	0	11	0	0				7870	802	0	0	10	3	0			
21833	926	12	0	4	4	3				13900	442	0	0	3	3	8			
4985	216	8	0	4	5	5				1100	27	8	0	2	8	0			
980	85	12	0	8	12	0				3060	267	12	0	8	12	0			
1285	99	9	5	7	12	0				1790	100	12	0	5	9	4			
7075	356	0	0	5	0	2				14815	382	0	0	2	9	8			
11170	389	6	0	3	8	0				7980	174	0	0	2	2	10			
4085	88	0	0	2	2	6				2580	29	6	0	1	2	6			
255474	16,478	8	2	5	6	4				210050	11,132	6	0	5	4	10			
	6,799	4	0	2	10	7					5,642	1	3	2	4	6			
	9,679	4	2	3	11	9					5,490	4	9	3	0	4			

MANUFACTURING OF BAMBOOS.

During the Great War and after the demand for manufactured bamboos was heavy and the Forest Department cut them into various other minor classes to suit military and local requirements, and dressed and straightened them departmentally before they were sold. With the fall in the market and the disappearance of the military demand the operation became unprofitable and was abandoned. Bamboos are now sold in their raw condition as they are cut from the forests, and the purchasers now have them dressed and straightened in their own workshops at the rates given below. These rates now differ somewhat from the rates the department used to pay prior to 1926-27 and do not include the cost of wood fuel consumed in the furnaces. This has been roughly estimated to be equal to the charges paid for straightening bamboos of each class.

Name of classes.	Dressing charges.		Straightening charges.		Total expenditure excluding price of fuel.	
	Paid by Government in and prior to 1926-27 per 100.	Now paid by traders per 100.	Paid by Government in and prior to 1926-27 per 100.	Now paid by traders per 100.	Paid by Forest Department.	Paid by traders.
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
Salam Kalan ...	0 8 0	0 8 0	4 8 0	0 0	5 0 0	4 8 0
Patti Kalan ...	0 4 0	0 4 0	1 8 0	1 8 0	1 12 0	1 12 0
Patti Khurd ..	0 3 0	0 3 0	0 14 0	1 0 0	1 1 0	1 3 0
Chhar I ...	0 6 0	0 10 0	3 0 0	4 0 0	3 6 0	4 10 0
Chhar II ..	0 6 0	0 8 0	3 0 0	3 0 0	3 6 0	3 8 0
Majhola ...	0 5 0	0 5 0	1 8 0	1 14 0	1 13 0	2 3 0
Mandhaoos ...	0 3 0	0 3 0	1 4 0	1 [illegible] 0	1 7 0	1 11 0
Sota Kalan ...	0 3 0	0 4 0	1 0 0	1 4 0	1 3 0	1 8 0
Sota Khurd ...	0 2 6	0 2 6	0 8 0	0 12 0	0 10 6	0 14 6
Tops I ...	0 4 0	0 4 0	0 10 0	0 14 0	0 14 0	1 2 0
Tops II ... and misc.	0 4 0	0 4 0	0 10 0	0 12 0	0 14 0	1 0 0

Bamboo clump properly cleaned, Karnpur.

Bamboo forest Karnpur, Mukerian Range.

Stacking of bamboos in Mukerian depôt.

Straightening of bamboos in Mukerian depôt.

The process of manufacturing is not an easy job. It requires hard labour, but it is interesting and paying to the workmen, dressers and straighteners, who can earn 12 annas and Rs. 2 to Rs. 3 a day respectively, during the nine months (October to end of June) of the year in which they work. The process consists first in heating the bamboos in furnaces and then straightening them by bending them through holes cut in upright wooden posts as shewn in the attached photograph.

SALE OF BAMBOOS BY TRADERS.

As already mentioned, the bamboo trade suffered a great set-back after the war. At the present moment the trade is at a very low level and is in the hands of a few people belonging to a small community of Sheikhs, who retail bamboos at the principal towns of the Province. The same people also deal in the bamboos of Lansdowne Division of the United Provinces. To give an idea of this trade figures have been compiled for the bamboo trade of Lahore at the present time and are believed to be accurate.

Statement showing total expenditure incurred by

Serial number.	Classes of bamboos.	Prices paid to Government during 1930-31, per 100.			Carriage to Railway Station at Mukerian per 100.			Loading charges per 100.			Terminal tax.			Freight.			Unloading at Lahore per 100.		
1	2	3			4			5			6			7			8		
		Rs.	a.	p.	Rs.	a.	p	Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.
1	*Salam Kalan II* ...	21	10	0	0	4	0	0	8	0	0	4	6	4	12	6	0	2	0
2	*Patti Kalan* ...	11	4	1	0	2	0	0	2	0	0	2	0	2	2	0	0	1	0
3	*Patti Khurd* ..	7	10	0	0	2	0	0	1	6	0	1	6	1	9	6	0	0	9
4	*Majhola* ...	5	1	6	0	2	0	0	2	0	0	2	0	2	2	0	0	1	0
5	*Mandhaoos* ...	3	4	7	0	2	0	0	1	6	0	1	6	1	9	6	0	0	9
6	*Chhar I* ...	15	1	4	0	2	0	0	2	0	0	2	0	2	2	0	0	1	0
7	*Chhar II* ...	10	3	0	0	2	0	0	1	6	0	1	6	1	9	6	0	0	9
8	*Sota Kalan* ...	3	3	8	0	1	0	0	0	9	0	1	0	1	1	0	0	0	6
9	*Sota Khurd* ...	2	8	0	0	0	6	0	0	4	0	0	6	0	8	6	0	0	3
10	Tops I ...	2	9	8	0	1	0	0	0	9	0	1	0	1	1	0	0	0	6
11	Tops II ...	2	2	10	0	1	0	0	0	9	0	1	0	1	1	0	0	0	6
12	Tops miscellaneous	1	2	6	0	1	0	0	0	9	0	1	0	1	1	0	0	0	6

purchasers on bamboos till receipt in their shops.

Carriage to shops per 100.	Octroi duty per 100.	Straightening charges per 100 including dressing and cost of wood.	Building and stacking per 100 including cost of bandages.	Incidental charges per 100.	Total expenditure.	Rate of sale in Lahore.	Profit per 100.
9	10	11	12	13	14	15	16
Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs a. p.	Rs. a. p.	Rs. a. p.
1 0 0	1 0 0	8 8 0	0 6 0	1 0 0	39 7 0	43 0 0	3 9 0
0 8 0	0 8 0	3 4 0	0 3 0	0 8 0	18 12 1	22 0 0	3 3 11
0 6 0	0 6 0	2 3 0	0 2 0	0 6 0	13 0 3	15 0 0	1 15 9
0 8 0	0 8 0	4 0 0	0 3 0	0 8 0	13 5 6	15 0 0	1 10 6
0 6 0	0 6 0	3 4 0	0 2 0	0 6 0	9 11 10	12 0 0	2 4 2
0 8 0	0 8 0	8 10 0	0 3 0	0 8 0	27 15 4	30 0 0	2 0 8
0 6 0	0 6 0	6 8 0	0 2 0	0 6 0	19 14 3	22 0 0	2 1 9
0 4 0	0 4 0	2 12 0	0 1 6	0 5 0	8 2 5	9 0 0	0 13 7
0 2 0	0 2 0	1 11 0	0 0 9	0 2 6	5 4 4	6 0 0	0 11 8
0 4 0	0 4 0	2 12 0	0 1 6	0 5 0	7 8 5	8 0 0	0 7 7
0 4 0	0 4 0	2 0 0	0 1 6	0 5 0	6 5 7	7 0 0	0 10 5
0 4 0	0 4 0	2 0 0	0 1 6	0 5 0	5 5 3	5 8 0	0 2 9

USES OF VARIOUS CLASSES OF BAMBOOS IN THE PUNJAB.

It is not much more than a decade or two ago that the superior classes of bamboos were mostly used in thatching roofs and in making beds but with the passage of time and improvement in the standard of living these uses have almost gone except in the case of the poorer classes who cannot afford timber for these purposes. The following gives the purposes for which the standard classes are mostly used :—

Salam Kalan ... For ladders and tent poles.

Patti Kalan ... For beds and poles of small tents and shouldaries.

Patti Khurd ... For small beds.

Majholas ... For thatching roofs in villages remote from railway communications and roofing cattle sheds.

Mandhaoos ... For tent kanats and the finest qualities for lance staves.

Chhars ... Shepherd's poles with a sickle at one end used for lopping trees to feed sheep and goats.

Sota Kalan ... The Punjab *zamindars' lathi* decorated with brass and re-inforced with lead.

Sota Khurd ... Ordinary handsticks mostly used by *zamindars* for driving cattle.

Sarancha ... Used in making chicks in the jails and by local chick makers.

Tops ... Used in making kanats of tents, thatching roofs of small cattle sheds, making flags and brought into numerous other daily uses.

14th March, 1931.

A SHORT NOTE ON THE UNCOVERING OF SAL REGENERATION IN GRASS IN THE GOALPARA FOREST DIVISION, ASSAM.

By P. D. Stracey, I.F.S.

An interesting piece of work was recently commenced in the Western Range of the Goalpara Forest Division, Assam. This sal division is situated in the Assam Terai and the main forests are contained in a broad belt lying along the base of the Himalayas. Parallel to this belt, and running approximately east and west throughout the whole length of the division is the North Trunk Road connecting Gauhati in Assam, with Bengal. In the western half of the division the sal ceases a short distance north of this road; south of it occur only a few small isolated patches of mature trees with no regeneration, surrounded by cultivation and doomed to eventual extinction. The intervening space between the sal belt north of the road and the cultivation south of it is occupied by a dense sea of grass in which stand scattered sal and other miscellaneous trees, triumphant inspite of the severe fires that sweep through these grassy areas annually during the fire-season. These scattered sal have served year after year as nuclei for the spread of regeneration, as an examination of the grass around them reveals. Year after year the seed has been scattered in ever-widening circles, only for the resulting seedlings to be burnt back, until what must have been a grim struggle between the fire and the sal has resulted in victory, though not complete, for the latter, thanks to its wonderful fire-resistant qualities.

An examination of these patches of natural regeneration discloses the fact that all the seedlings spring from greatly enlarged root stocks, the result of successive 'burnings-back' over a long series of years, and moreover that almost every one of the older, and a large proportion of the younger seedlings, have suffered badly from the effects of fire, being hollow and rotten from the roots upwards to varying heights, in addition to such external signs of fire-damage as forking and cracking of the stems. This provides the reason, then for the high percentage of unsound-

ness that is generally to be found in sal forests that have originated in grass.

To return. Having located the patches of regeneration, the work of freeing the best of them from the grass was taken in hand at the commencement of this working season. Fire-lines were first cleared to enclose areas of suitable size around the mother trees, and the grass on these areas was then carefully cut away at ground level so as to free the seedlings, carried to the surrounding fire-line, piled, and later burnt. It was necessarily slow work, both because of the danger of damaging the seedlings and because only a very rough idea of the direction in which the regeneration extended was possible under the circumstances, but the element of uncertainty lent an added zest to the search, and it was pushed on as fast as possible. The result, in almost every case, was beyond all expectations. The best of the patches revealed themselves as dense waving masses of regeneration of a beautiful green colour and of all sizes and stages of development a sight indeed to gladden the heart of the forester, while the worst of them contained sufficient seedlings to ensure complete stocking in the future. It was instructive to note, in the most typical of the patches, how the regeneration fell away in height and thickness with age from the mother-tree outwards, from tall stout saplings with thick woody bark nearest the parent trees, through erect 'fleshy' stems to 'whippy' trailing seedlings on the outer edges. In one or two patches the 'fleshy' established stage was found to be completely absent and the majority of the seedlings had, for some unknown reason, refused to emerge from the 'whippy' unestablished stage, although showing unmistakable signs of considerable age and repeated burnings in the form of enlarged root stock and damaged stems. Whether these seedlings only await the stimuli of further burnings to enable them to get away with a burst to the 'fleshy' stage or whether their condition is the result of some adverse soil factor, is a matter for further observation and experiment. At the commencement of the growing season early in January, the patches were heavily thinned of all inferior and damaged stems, irrespective of their age and size, and the

A patch of sal natural regeneration before being thinned of damaged stems. Note the small seedlings in the fore-ground. Mother-tree in right corner.

A fine patch of fleshy established sal natural regeneration found in grass. Part of the mother-tree responsible for this is to be seen in the right fore-ground.

The same patch as shown in photo 1, taken after coppicing of damaged stems. Note the heavy removal. Mother-tree in right corner.

Showing part of the largest patch. The mother-tree is seen to the left of the picture.

extent to which this work was found to be necessary is obvious from the accompanying photographs.

Over sixty acres in all of this natural sal regeneration, a gift of the Gods, has been uncovered at a cost of something more than ten rupees per acre, and there still remain several good patches to be tackled. But, although as an experiment the operation has been entirely successful, and has moreover proved conclusively that sal does, and can, regenerate itself under cover of thatch grass, it does not appear to be worth while to continue uncovering further patches indiscriminately, if only because of the difficulty and cost of adequately fire protecting them in this sea of highly inflammable material. Moreover it is well-known how easily small scattered patches of regeneration, natural or otherwise, tend to be forgotten and eventually to disappear as a result of frequent changes of personnel in the subordinate staff. What appears to be indicated in the future, or at any rate during the next few years, is a gradual linking-up of the largest of these patches with each other and with the main belt of sal forest, by assisting nature in her work of regeneration by such means as fire-protection and the broadcasting of seed, preferably on ploughed strips or lines. There are at present two or three such areas, the work on which will more than suffice to keep the range staff busy for some years to come, and with this work completed, attention may be directed to the remaining patches, which in the meanwhile will have automatically increased in size.

In conclusion one cannot help regretting the frost-hazard of the United Provinces, which makes such work impossible in the *chandars* of Pilibhit and the *phantas* of Kheri. We, in Assam, have at least one blessing to be grateful for, and that is the absence of Jack Frost.

NOTE ON THE REGENERATION OF CEDRUS DEODARA (DEODAR) BY THE SHELTERWOOD SYSTEM IN LOLAB RANGE, KASHMIR.

By H. S. Jamwall, M.F., D.F.O., Langet Division.

1. The Shelterwood system was introduced, for the first time in the history of the Kashmir Forest Department, in Lolab Range

of old Kamraj Division in the year 1924-25 (*i. e.*, Sambat year 1981).

The first marking under this system was done in 1924 by S. Sher Singh, (then) A.C.F. and author of the New Plan. The work has since been carried on according to the prescriptions of the Plan, with the exception of the Fir Working Circle, which has been left unworked due to the very low price prevailing for fir timber down in the plains.

2. Ever since the inception of the Shelterwood system in the Valley, the prevailing opinion of Forest Officers in general and of casual visitors in particular is that the regeneration in deodar and *kail Pinus excelsa* areas is not keeping pace with the fellings and that the system is not suited to the Kashmir Forests.

This idea, erroneous as it is on the face of it, seems to have gained ground from the unsatisfactory condition of regeneration after fellings in Compartment 25 at Chandigam in the Southern Lolab Range. Though it is a fact that in some areas regeneration is not following the fellings as promptly as was anticipated, yet in others it is already so profuse that nothing more can be desired.

3. The condition of Compartment 25 at Chandigam is ostensibly serious and here the situation has been aggravated more by the factors narrated below than by the system itself:—

(*a*) Since the introduction of the New Plan and System there had apparently been no good seed year till last year *i.e.*, after about 7 to 8 years.

(*b*) In spite of the continued dearth of deodar seed for so many years for natural regeneration, little attempt appears to have been made each year to regenerate some portion of these areas artificially by raising nursery stock.

(*c*) Instead of forming small nurseries in P.B.I. areas efforts were made to restock part of the cut-over areas by transplanting forest seedlings that were dug up by the *zemindars* (villagers) and planted in the

blanks by the Forest Guards who had little or no idea of the technique of deodar planting.

(*d*) In fact, no definite method of planting and sowing of deodar seed with regard to *time* and *place* has so far been evolved in Kashmir and the consequence is, as one would expect, that no satisfactory results were obtained, since the operations mentioned above were carried out in a haphazard manner in the past, whenever and wherever the officer-in-charge directed the subordinate staff to do so.

4. The failure of the Plan was almost certain in view of the slip-shod methods tried and the whole outlook was so dismal that notes of warning as to the failure of the Shelterwood system in Kashmir were not infrequently sounded both by some of the Forest Officers and by the general public.

5. The Lolab Range was annexed to the old Langet Division of Private Domains last year and since then the writer took over charge of these forests.

Fortuitously last year was a good seed year and taking into consideration the gloomy state of affairs in the past, the writer had about 415 maunds of deodar seed collected in his division and made four small nurseries in different P.B.I. areas in Lolab and adopted the following different methods of sowing both in the nurseries and in the cut-over areas in general :—

(*a*) Broadcast sowing of deodar seed at different intervals as stated below :—

(*i*) In early autumn *i.e.*, in the month of October.

(*ii*) In late autumn *i.e.*, in the month of December when snow was about to fall for the first time in the Valley or when there was a little snow on the ground.

(*iii*) In early spring *i.e.*, in the month of March when the snow was just melting or when there was just a thin layer of snow on the ground.

(*iv*) In late spring *i.e.*, in the month of April.

(*b*) The seed was sown as described above in ash-beds after they had been thoroughly cleared of accumulated ash and charcoal.

(*c*) Again seed was sown in the area cleared of grass and weeds and hoed up in the autumn.

(*d*) In some places grassy patches were burnt and seed was sown broadcast.

(*e*) Still in other places the soil was hoed up and turned over around the seed bearers in P. B. I. areas.

(*f*) Finally, in places seed was sown in lines and patches 12″ × 16″ and 6″ deep behind *Indigofera* shrubs so as to take advantage of the afternoon shade.

The germination of seed, thus sown at different intervals in all these localities, is simply marvellous so far and each ash-bed virtually forms a nursery in itself in the very heart of these forests.

However, from all the different methods so far tried and the results obtained, it is clear that the best results are obtained from the late autumn and the early spring sowings, and that *site* and *aspect* are immaterial from a germination point of view, if the seed is sown at the proper time. In fact the results so far obtained clearly prove that a broadcast sowing of deodar seed in the forests in late autumn gives the best results, while in case of nursery beds the earliest spring sowings are preferable to early autumn or late spring sowing.

6. On the other hand, there is no gainsaying the fact that experience in this division has definitely shown that early autumn and late spring sowings of deodar seed are simply a waste of time and money, and may advisably be discarded altogether, for in the former case the seed is eaten in large quantities by monkeys and mice. The damage is so great that monkeys have often been noticed following the sowing party and clearing up the seed from the ash-beds which have just been sown. Large quantities of eaten seed are also often seen in front of the rat holes occurring near nurseries and ash-beds.

In the case of late spring sowings the results obtained are so poor as to make the operation not worth the money and the

energy expended, for seedlings grown so late in the season hardly keep pace with the drought and thus generally dry up at the very first spell of hot weather.

7. Finally, it must be borne in mind by those who are confronted with a similar problem that the making of small nurseries under the Shelterwood system is an absolute necessity and that the regeneration of some blanks is out of question without nursery stock.

The seedlings from the forests so far transplanted in such blanks have given no results and have proved an utter failure over and over again in this Range. It will be, therefore, unwise to resort to them any more in filling up the old gaps or lower flats in P. B. I. areas.

In order to prove the futility of prescribing the transplantation of forest seedlings in any programme of artificial regeneration, even on small scale, the following comparative results are given for the perusal of those who may place great reliance on forest stock :—

Statement showing the comparative results of transplanting nursery stock and seedlings from the forests :—

Locality.	Kind of stock transplanted.	Species of seedlings.	Number of Seedlings.			Percentage of success.
			Transplanted.	Success.	Failure.	
Mawar ...	(1) Nursery stock two years old.	Deodar ...	1249	1403	26	98·2
Lolab ...	(2) Forest stock.	Deodar & *Kail*.	9800	654 Deodar 604 *Kail* 50	9146	6·6

The above results, though obtained in two different localities (the two operations not having been carried out in one and the same locality), will, I believe, give the lie to the popular idea of the transplantation of seedlings from forests.

The difference in locality in this particular case does not seem to play a prominant rôle and the fact remains that nursery stock

is the only stock that can be depended upon for filling up blanks in forests worked under the Shelterwood system.

8. The above brief synopsis of work done during the short period of one year, is given, not only for the information of Forest Officers engaged in similar work in other divisions, but also to invite their remarks and helpful suggestions. For the above findings of the writer in this division are by no means final, and unquestionably there seems much to be implemented therein from the observations of other Officers.

In case any Forest Officer, particularly in Kashmir, has followed lines of action for securing deodar regeneration, diverse to those mentioned above and has achieved better results, he will very kindly offer his remarks so that from such sound criticism some more useful method of obtaining deodar regeneration by this system may be evolved to guide our future endeavours.

As there does not apparently seem to be anything wrong with the Shelterwood system in Kashmir Forests, there must be something lacking in the technique hitherto followed by some of the Forest Officers.

In fact, the writer believes that Kashmir Circle is the most suitable place for this system and that these forests surely offer ideal ground for the successful working of this intensive system of management.

LOLAB,

4th August, 1931.

POONA DIVISION.

BY E. A. GARLAND, I.F.S.

The Poona Forest Division covers a roughly "boot-shaped" area of approximately 6,550 square miles, between 18° 15′ and 19° 45′ north latitude, and 73° 19′ and 75° 10′ east longitude. The "toe" of the boot is towards the east and is formed by the junction of two important rivers, the Bhima and the Nira. The back of the boot is the Sahaydris or Western Ghats. This immense ridge which runs almost due north and south, the

crest of which forms the western boundary of the division, dominates the whole area topographically, climatically and in its effect on communications. Though there are various footpaths and pack-bullock tracks which cross the Ghats westward down to the Konkan, the only metalled road throughout the whole length of the division, connecting it with the west, is the main Poona-Bombay Road, which crosses the Ghats at Khandalla. The G.I.P. Railway also crosses at the same point.

The peaks of the Sahaydris rise as high as 3,700 feet above sea level, and running eastward from the main ridges are many spurs which gradually sink to the main level of the Deccan plain, at about 1,000 feet above sea level, in the south-eastern corner, or "toe" of the division. Between these spurs through fertile valleys, run considerable rivers which all rise in the Sahaydris and eventually join as tributaries of the Bhima, which for some 50 miles forms the eastern boundary of the Division. The Pravara and the Mula in the north, however, join the Godaveri. Through communication north and south between these various catchment areas is impossible, on account of the height of the spurs as they go to join the Sahaydris, until about 30 miles east of the main ridge where the Nasik-Poona-Belgaum road runs roughly parallel to it. From this various branch roads radiate east and west along the valley. The other main roads of the Division are those which join Poona, the monsoon headquarters of the Government of Bombay and the headquarters of the Southern Command, with Bombay, Ahmednagar, and Sholapur. Poona as well as being on the G.I.P. Railway is the junction for the M. and S.M. Railway.

The ridge of the Sahaydris also has an immense effect on the climate causing a very heavy precipitation on the ridge itself and a very marked "rain shadow" east of it to leeward. Thus while the average fall at Lonavla close to Khandalla is 165 inches that at Vadgaon, only 17 miles to the east, is 37 inches, while in Poona itself, 24 miles south-east of Vadgoan there is a further drop to 21 inches.

These rapid changes within such short distances have a direct effect upon the vegetation, since a very large portion of

the area thus becomes a succession of tension belts where no one vegetational formation can find optimum conditions. This fact combined with the steady depredations of centuries of hacking and grazing has reduced most of the central area to a stage where tree growth has largely given place to grasses and shrubs. The steep hillsides have been increasingly exposed to erosion and the whole vegetational cover is in a very critical state. Even in the Sahaydris themselves, where the heavy rainfall and lower temperature produce a climate in which evergreen forest formations are the natural climax, the forests have been steadily pushed back to the higher peaks and the more inaccessible ledges where the hand of man has been less heavy upon them. There are, however, in my opinion definite indications, in the remnants that remain, of two climatic climax formations, the high elevation dwarf evergreen of which *Memecylon Edule* is the dominant species, and the lower elevation evergreen which has as dominants *Terminalia* s.pp. and *Mangifera indica.* These formations are definitely less luxuriant than the typical evergreen rain forest and must always have been differentiated from the latter by the fact that though the annual rainfall is very heavy it is definitely monsoon with a well marked dry season from December to May. Next in the central area, of which the climatic climax would be mixed deciduous forest changing steadily from wet in the west to dry in the east, on account of the factors mentioned above, we find deciduous forest in which the canopy is rarely closed; shrubs and grasses are prominent and owing to poverty of soil gregariousness is strikingly common. Thus on cooler northern slopes or round nullah beds where moisture is greater *Terminalia tomentosa* is dominant on better soils, *Anogeissus latifolia* and *Ougeinia dalbergioides* on poorer soils on the upper slopes, while on hot dry southern or western slopes *Boswellia serrata* is frequently alone representative. On lower slopes where a somewhat greater depth of soil remains teak occurs often as a pure crop stunted and only in the less degraded areas mixed with other deciduous species. Of shrubs *Carissa Carandas* is most representative in the moister areas, *Gymnosporia emarginata* in the drier.

Strobilanthes callosus is associated with the dwarf high altitude evergreen formation as an early stage in the succession. Lantana has frequently invaded the central area to the exclusion of all other shrubs and grasses. Of grasses the most important commercially are *Andropogon annulatus* and *Ischaemum laxum* and areas producing these fetch high prices for grazing. The most commonly found grasses are *Anthistiria ciliata* and *Ischoemum pilosum* both of which are very fair feed while green but make coarse hay. *Aristida paniculata* and *Andropogon contortus* (both perennial and annual) are usually strongly dominant on the poorest soils and the latter frequently on better sites which have suffered severely from overgrazing. These are "spear grasses". They represent early stages in the grass successions. In the eastern area of low rainfall thorn forest with the usual dominants *Zizyphus Jujuba, Acacia Latronum* and *Prosopis spicigera* occur everywhere except along the banks of the rivers where flood water during the rains or infiltration from permanent pools allows *Acacia arabica* to become a pure crop. Further west where the rainfall is greater *Acacia arabica* tends to grow freely wherever there is black soil. Since such soil is highly fertile and usually required for agriculture it seldom has any opportunity to appear as a crop but springs up along the banks of fields or even on fallows with surprising rapidity. This tree may be said to supply practically the entire firewood of the district, while its leaves and pods are much valued as feed for sheep and goats. The few Government Forests which contain soil suitable to its growth are of very high value, especially near Poona, the chief market for firewood.

The underlying rock is everywhere Deccan Trap. Beds of basalt and amygdaloid alternate, their upper and lower planes being strikingly parallel with each other but with a general fall in level towards east-south-east and south-east. Trap weathers into a disintegrated form known as "murum" and finally produces soils of varying depth, texture and colour. These are locally classified as black, red and grey. The black soils are often excessively rich and moisture holding. The red are always

shallow and often mixed with gravel. They occur chiefly in the west. The grey are very loose friable and in consequence much subject to erosion.

The district is full of history both recorded and unrecorded. Forts, temples and Buddhist caves abound. The former are mostly situated on the tops of isolated hills. Almost perpendicular scarps of basalt, naturally formed, made these forts almost inaccessible and the fact that springs of good water often occur on their summits made them merely impregnable except by treachery. The most notable of these forts are Singad near Poona and Shineri near Junnar. Both of these are intimately connected with the history of the Mahratta hero Shivaji, who was actually born in the latter. The division is also unique in having the longest forest history of any in India since here Dr. Gibson, who was the first Conservator of Forests ever appointed in India, had his headquarters at Hivre near Narayangaon. Gibson's appointment actually dated from 22nd March, 1847, the Government of India having sanctioned on 19th December, 1846, "the employment of an establishment for the management of the forests under the Bombay Presidency at a monthly charge of 293 rupees." It is not stated whether Gibson's salary was at all debited to this princely grant but as he was also Superintendent of the Botanical Gardens it is probable that the whole sum may have been available for his establishment. From such small beginnings have grown the present Forest Services of India. There is also in existence in the India Office records a report quoted by Stebbing in his monumental History, written in 1843 by Col. Jervis, Chief Engineer at Bombay for the Military Board, which gives a detailed account of all the teak-bearing forests of the Presidency. In this the forests of Poona Division are described in some detail and preservation of teak in them is ascribed to the 'provident care' of the Mahratta "Nana Furnavese and others." Much could be written of the early struggles of Gibson to get adequate reservations made and of the final intervention of the Governor of Bombay himself, Sir Richard Temple, almost exactly 30 years later in 1878. Since then the areas held by

Government on behalf of the people have remained substantially unaltered, though considerable portions originally intended for reafforestation have since been handed over to the Revenue Department for maintenance as grazing grounds.

Taken as a whole, the areas in the division, which can be managed under accepted forest methods, are not extensive. The evergreen areas in the west are too remote and inaccessible since their component species have no value at present except as fuel or for conversion into charcoal. From these myrabolams are the chief commercial product. In the centre most of the areas had undergone too great denudation and erosion before they came into our charge for them either to continue to carry a complete crop of higher tree vegetation, or to render its restoration possible except by laborious and expensive minor engineering works to check existing erosion and gradually build up again a sufficient depth of soil. Herbaceous vegetation, therefore, formed a very large proportion of the growing stock and grazing interests were of paramount importance. Unfortunately the necessity for limitation of the intensity of grazing, if the quality was not to deteriorate, was not sufficiently realised. The whole question of the methods of management to be applied to these areas is again at present under consideration. A new working plan is being written and the bearings of the recommendations of the Report of the Royal Commission on Agriculture on the treatment of such areas are being reviewed. Only in those areas of the Government Forests which produce pure *Acacia arabica* crops can pure systematic forest management be practised. These areas are immensely valuable.

A feature of the district is the number of artificial lakes which have been made. Of these, Bhandadara in the north in Ahmednagar Collectorate and Khadakvasla near Poona were constructed by Government and the water so stored up is utilized for irrigating the arid eastern tracts in Poona and Ahmednagar Collectorates. Andhra Lake, Shiravte Lake, Valvhan Lake, and Mulshi Lake have all been constructed by the Tata Company and the water from them is carried westward by pipes

down the Ghats to supply power for the hydro-electric schemes.

Mahseer fishing can be had in most of these lakes by trolling and in parts of the Pravara and Bhima rivers with rod and line. Mixed shikar is available for the enthusiast all over the district, but it has to be searched for and is nowhere really plentiful. A very rare tiger is sometimes said to be found along the Ghats. Panther are relatively common. Black buck and barking deer are all found, as are partridge, sand grouse, peafowl, duck, snipe and quail.

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SHEEP GRAZING IN CONIFEROUS FORESTS.

BY C. G. TREVOR, I.F.S.

Sheep are animals which prefer short pasturage and the finer grasses and hence they are found on the upland pastures and the hill grazings of Great Britain. Rank grass which is useful for cattle is quite unsuited to sheep and in many parts of the world cattle country and sheep country are quite distinct. In India sheep, when driven by hunger, browse shrubs in the same way as goats. I have seen a flock living on the withered leaves of *sanatha* (*Dodonea viscosa*). The winter grazing is the real problem of flock management in India. The summer pastures are excellent, the sheep return fat from the alpine grazing and then more or less starve through the winter. Mr. Pring in his article advocates sheep grazing on fire lines and there can be no objection to this, but sheep and *chir* pine do not go well together; *chir* pine country is not sheep country. Even in Kangra the sheep frequent the scrub forests below or the oak forests above the pine. It has been suggested that a sheep industry might be started in Rawalpindi, sheep cannot be expected to do any good in a *chir* country where they have no summer pastures and the advocates of such a policy can have no personal knowledge of sheep. As regards forest grazing the greatest mistake is to be dogmatic. In some cases grazing does no harm and natural regeneration will come up in spite of grazing. In others grazing will inhibit reproduction altogether. This is

entirely proved by the Forest Research Institute experimental plot in *Bajraundi, Kulu Division, laid out by Professor Troup* and myself. The fenced plot is beautifully regenerated and outside there is nothing. At the time the plot was started there were masses of germinating seed both inside and outside the plot. Grazing is a question of degree and excessive grazing will deteriorate any wild pasture as the Americans have found. Generally the incidence of grazing in India is excessive and it is the excessive number of animals grazed per acre and not mere grazing which destroys the forest and is responsible for the ruin of the outer hills. Goats are always bad and the forest officer cannot be expected to view them with any pleasure; their substitution by sheep would be to the good of all concerned.

LOSS OF INCREMENT IN TEAK DEFOLIATION.

BY C. F. C. BEESON, I.F.S., FOREST ENTOMOLOGIST.

Although the economic results of the defoliation of teak plantations has been the cause of much speculation and some anxiety to forest officers for many years, none, as far as I am aware, has succeeded in making accurate measurements of the loss of increment. Several obstacles stand in the way, of which the most important are that the defoliators are normally active throughout the growing-season; the two most injurious species, *Hyblaea puera* and *Hapalia machaeralis*, have 12 to 14 generations a year; the minor pests such as grass-hoppers, cockchafer-beetles and weevils attain prominence when the caterpillars are scarce; after a complete loss of foliage teak puts out a new flush and may do so more than once in a growing-season; to record whether appreciable defoliation does or does not take place it is necessary to make observations at intervals of not less than a month.

It is, therefore, not surprising that estimates—which are really guesses—by officers thoroughly acquainted with teak plantations vary from as much half the total annual increment to a fraction that is economically a negligible amount. Mackenzie in 1921 (*Indian Forester*, pp. 309—317) calculated the financial results of a loss of increment equivalent to one-twelfth of the

annual growth, but stated that he considered this incidence much below the actual. Minchin in 1929 (*Proc., Third Silvicultural Conference*, p. 83) suggested that the loss in Nilambur is one-third of the increment that should accrue.

As part of the biological work in progress on teak defoliators monthly records have been made of the intensity of defoliation compartment by compartment over the whole of the Nilambur teak plantations since 1926. A preliminary analysis of these data throws some light on the problem of economic loss. During the four-year period under consideration, August 1926 to July 1930, one serious pre-monsoon epidemic occurred in 1930 and one post-monsoon epidemic in 1926, and one year, 1927, was practically free of economically important defoliation; the remaining seasons suffered more or less heavy defoliation of variable extent. For each of the 350 compartments in the three blocks 1—118, 119—221, and 247—374, there are on the average 34 records, that is to say, one for each month of the growing-season of eight to nine months over four years. The intensity of defoliation was recorded in the field by seven grades, which for the present purpose have been combined into three, *viz.*—(1) No defoliation, (2) Light defoliation of negligible economic importance, (3) Severe defoliation. The grading of the compartments was necessarily done according to arbitrary standards but, *défaut de mieux*, it is considered that compartments classed in grades (1) and (2) represent conditions under which there was no economic loss of increment, and compartments in grade (3) suffered a loss of one month's growing-period for each observation.

The frequency of occurrence of the three grades of defoliation expressed in percentages of the total number of observations (11,700) works out as below :—

Block	PERCENTAGE FREQUENCY OF MONTHLY OBSERVATIONS.		
	(1) None	(2) Light	(3) Severe
Cpts. 1—118	54·6	38·4	7·0
Cpts. 119—221	61·4	32·4	6·2
Cpts. 247—374	47·5	41·7	10·8
Whole Area	53·9	37·9	8·2

According to the definition assigned to grade (3) it must be concluded that the increment lost over the whole of the Nilambur plantations was that normally formed in 8·2 per cent. of the growing-season.* It is moreover the increment of a plantation with a previous history of chronic defoliation, not the increment of a plantation periodically immune from pests.

The assumptions made in the foregoing estimate are many. They are (*a*) that the volume increment of the tree is proportional to the volume of its foliage and the loss of increment is proportional to the foliage lost, (*b*) that the monthly increment is uniform throughout the growing-season, (*c*) that there is no residual effect from the defoliation of one month on the increment produced in the next month, (*d*) that the full increment is put on during the period of second flush, (*e*) that the defoliation of one whole growing-season has no effect on the "reserves" available at the beginning of the next.

I am aware that any one of these assumptions invalidates the conclusion drawn, but by making them the conclusion becomes one stage better than a guess. For example, the units of severe defoliation practically all occurred in the pre-monsoon period April to June, except for one post-monsoon epidemic in block 247—374; monsoon and post-monsoon defoliation was either light or *nil.* If the increment of the first third of the growing-season is relatively greater than that of the later two-thirds, then the total increment lost is more than eight per cent.

And again, it is not impossible that complete stripping by stimulating a second flush actually increases the increment temporarily above the average, although the residual effect may lower the total increment of the immediately succeeding years. And further, it is not impossible that light defoliation in every month of the growing-season may have a total effect as great as that of complete defoliation late in the season.

Sample plots measuring the girth-increment of trees subject to defoliation are being maintained at Nilambur, but to interpret

* A loss of 8·3 per cent., or one-twelfth, according to Mackenzie's calculations may be valued at Rs. 1-3-0 per acre per annum on a 130-year rotation, and a loss of 6·6 per cent., or one-fifteenth, is Rs. 2-3-0 per acre per annum on a 80-year rotation, at 3 per cent. C. I.

the data satisfactorily information is required on the physiology of normal and pathological increment-production. Such studies, as I pointed out in 1928 (*Indian Forester*, p. 215), are outside the scope of entomological research and should be undertaken by a botanist or silviculturist.

SOME EXPERIMENTS ON A NEW IDEA FOR WOOD PRESERVATION.

BY F. J. POPHAM, F.I.C., OFFICER-IN-CHARGE WOOD PRESERVATION SECTION, F.R.I., DEHRA DUN.

The possibility of the ideas described below were based upon some previous experiments and some of the known facts relating to preservatives.

The experiments were conducted to determine whether preservatives passed into the cell walls, remained in the cell spaces, or both.

The results indicated that preservatives could be divided into two classes :—

(1) Those which passed into the cell walls causing swelling.
(2) Those which did not pass into the cell walls but were retained in the cell spaces.

Amongst the first class are water soluble salts, phenols and alcohols, etc. Amongst the second are neutral hydrocarbons *e.g.*, petroleum and creosote free from tar acids.

It was to be expected that if a mixture of preservatives of each class was used, then some equilibrium would be established.

The system of immediate interest was the system set up by using creosote containing phenols or tar acids. The results showed that if creosote contained over 20 per cent. tar acids, a measurable amount of these tar acids passed into the cell walls, and a system tar acid/cell wall and tar acid/creosote was formed.

If neutral petroleum oils were substituted for creosote, a similar equilibrium was set up.

Tar acids are toxic to fungi and termites, but are dissolved out of wood quite readily in the rains. For this reason a high percentage of them in creosote is not desirable.

It has been frequently asserted that petroleum products rendered wood more or less waterproof. Experiments on fuel oils have indicated that this statement is probably not correct, but it was thought that a permanent preservative might be made by mixing tar acids and cheap paraffin wax residues in such a way that the tar acids would impregnate the cell wall, either directly or by utilising the established equilibrium, and that the wax residues would form a solid film over the impregnated cell wall and so seal it.

Three experiments were therefore conducted. The timber used was *Mangifera indica*, a species readily treated. Three 2" blocks were treated with hot material to saturation, as follows :—

(1) Wax residue alone (setting point 55°C).

(2) With tar acids to saturation, followed by hot wax residues.

(3) With a mixture of tar acids and wax residues in equal proportions. (Setting point of mixture 38°C).

The treated samples were placed in cold water. Tar acids immediately began to leach out of the samples of Nos. 2 and 3 and the leaching continued for 3 days, when the samples sank in the water, indicating a considerable absorption of water. The sample No. 1 also sank in the same period, indicating that it was by no means waterproof, although the result in the latter instance taken by itself might indicate that water had passed into the cell spaces and not necessarily into the fibre.

Samples of Nos. 2 and 3 were placed in fresh water each day for 14 days. Tar acids were still being leached out quite vigorously at the end of that period.

The process would, therefore, appear to be of little value, but further very definite evidence was obtained that the waterproofing qualities of paraffin products are not what they are supposed to be.

FELLING CYCLE AND ROTATION IN THE BAMBOO (DENDROCALAMUS STRICTUS) FORESTS OF THE PUNJAB.

BY N. P. MOHAN, I.F.S.

Chaudhri Fateh Mohammad, Extra Assistant Conservator of Forests, in his article "The Bamboo Forests of Hoshiarpur District, Punjab," which appeared in the *Indian Forester* for October 1931, advocates the suitability of a three years felling cycle. He says :—

"Cutting cycle. At present the forests are being worked on a two years cutting cycle. Experience has shown that bamboos less than three years old are immature and the market will not have them. On comparing data collected from the records of the sample plots laid out in Karnpur forests to determine the felling rotation of bamboos, it is evident that the production of superior classes of bamboos is 5·79 under two years rotation and 13·27 under three years rotation. Both these factors combined with the gradual fall in demand are sufficiently sound reasons for reducing the present working areas and increasing the cutting cycle from two to three years."

In other words three reasons are advanced for the change in the felling cycle; *viz.*, (i) three years old bamboos are immature and unmarketable, (ii) Karnpur sample plots figures show a higher production of superior class bamboos under three years rotation than under two years rotation, and (iii) fall in demand.

2. As a preliminary requisite we must be clear as to the terms we employ, particularly because considerable confusion exists with regard to the use of the words 'Cutting cycle', 'Felling cycle' and 'Rotation' when applied to the working of bamboo forests. Cutting cycle is not a standard term and may, therefore, be discarded. Felling cycle is defined in the Glossary of Technical Terms (Indian Forest Record, Vol. XV, Part II) as "the time which elapses between successive principal fellings on the same area"; while rotation represents "the number of years determined upon between the formation or regeneration and the final felling of a forest crop". A clump is the unit of working in a bamboo

forest and the felling rules never prescribe its clear felling (unless it flowers) or the removal of culms beyond a fixed age or certain definite specifications. In the Punjab bamboo forests rotation has never been determined nor can it be accurately fixed until a method for finding out the age of culms has been discovered. What in common parlance is taken to be rotation is in reality the felling cycle.

A bamboo clump may in fact be compared to a miniature selection forest in which all age gradations are collected together over a small area—a few square feet. In the High Selection Forest the rotation corresponding to the exploitable size applies to the individual trees, while the entire forest can be gone over every year if the intensity of management makes it possible to do so; otherwise the length of the felling cycle varies. In the case of a bamboo clump the rotation applies to the individual culms and the felling cycle to the time which elapses between successive principal fellings in working the same clump. Both the rotation and the felling cycle in the case of a bamboo clump are, however, low; the rotation, if it could be determined, may not perhaps exceed 5—8 years, while the felling cycle may be annual, biennial and triennial (or some times quadrennial). In the case of annual fellings the conditions are akin to the ideal selection system; while biennial and triennial felling cycles represent the periodic selection system. It is thus clear that rotation and felling cycle apply to culms and clumps respectively. If the intensity of management can permit of annual fellings, it would not necessarily follow that the fellings will be heavy unless the rotation of culms is reduced and raw and undermature culms are cut.

3. This brings us to the first argument for lengthening the felling cycle from two to three years; *viz.*, three years old culms are immature and unmarketable. With an annual or biennial felling cycle, it does not follow that all culms of three years and over are cut. If no demand exists for three years old bamboos, lengthening of the felling cycle cannot ensure their retention, if the felling rules do not prohibit their removal. If three years old bamboos are being cut under the existing felling

rules, it is necessary to modify the felling rules; a change in the felling cycle is no remedy. Whatever the duration of the felling cycle may be, the felling rules, based as they are on the exploitable size or the age at which a tree or culm attains maturity, can alone result in the retention or removal of individual culms.

4. The sample plots figures (*vide* paragraph 1 supra) require a careful examination before they can be accepted. There are two sample plots in Karnpur forests, sample plot No. 1 and No. 3. The former was laid out in 1916-17 and all the clumps were properly cleaned and felled to create uniform conditions for the clumps under the three felling cycles, annual, biennial and triennial. The following felling rules were prescribed:—

(*i*) All shoots were to be cut within one foot of the ground, (*ii*) *no portion of the cut shoot was to be left in the* clump, (*iii*) no shoots of the year or of the previous were to be cut, (*iv*) outside shoots unless dead were not to be cut, (*v*) shoots left uncut were to be evenly distributed over the clump, and (*vi*) from the annual felling cycle clumps not more than half the living old shoots (three years old and over) were to be cut; from the biennial felling cycle clumps not more than $\frac{2}{3}$rd of the living old shoots were to be cut and from the triennial felling cycle clumps not more than $\frac{3}{4}$th of the living old shoots were to be cut.

The last was the most important rule and, tending as it did to prescribe a mechanical rule instead of a silvicultural one, vitiated to a considerable extent the value of the data collected. Inspection in October-November 1918 showed that the triennial felling cycle clumps were beginning to become congested; in fact they had become sufficiently dense for an ordinary cooly working on piece work, only to skim round the outside and not to fell them properly. On the other hand, the clumps under the annual felling cycle had become too open. A change in the felling rules was therefore indicated, it having become apparent that the number of the culms to be cut depended entirely on the condition of the clump. Rule (vi) was discontinued and the general

principles adopted were the evenness of the distribution of the unfelled culms in a clump, ensuring of sufficient support for the young bamboos and the prevention of the splitting up of culms. Rule (iii) was also modified to permit the removal of useless, crooked top broken shoots less than two years old at the time of cutting. It may, however, be emphasised that no steps were taken to bring the clump to a uniform condition with the change in the rules; clumps under the three years felling cycle remained congested while those under the annual felling cycle continued open. In 1918 the clumps under the biennial felling cycle were felled by mistake which nullified the data previously collected. The plot was thus deemed to have started from 1919-20.

The comparative figures in paragraph 1 supra are based on the data collected between 1919-20 and 1929-30 *i.e.*, 11 years. Apart from the fact that comparative figures must be for a period which should be a multiple of 1, 2 and 3 *i.e.*, for 6, 18 or 24 years, the figures can only be accepted with the greatest caution for the following reasons:—

(*a*) Biennial and triennial felling cycle clumps have not been regularly felled in the years in which fellings were due. This alone makes any comparison impossible.

(*b*) In 1920-21, 52 culms of some 19 clumps were found to be dying on account of insect attack.

Three clumps flowered which affected eighteen culms. The rules were again changed and the removal of the bad and the best bamboos (wherever they were congesting the clump, whether they were three years old or not) was prescribed; but again the clumps were not brought to a uniform condition.

(*c*) In 1922-23, the Conservator of Forests doubted the accuracy of the figures collected by then.

Sample plot 3 Karnpur forest was laid out in January 1919 when a change in the felling rules for sample plot 1 was effected. But the selection of the plot was poor as the aspect was south-western (a bad one for bamboos) and no clump of the plot or in the neighbourhood was congested. In addition to the objections

detailed in the closing part of paragraph 5 supra, many clumps were too open to admit of any felling for a number of years.

Data collected from these two sample plots can hardly be relied upon for the scientific determination of the felling cycle.

5. The third argument of subordinating silvicultural treatment to economic conditions finds an active expression in the management of High Forests where delaying the fellings for a few years for the realization of better prices is not an uncommon feature. The case of bamboo forests is, however, different. Lack of working results in the congestion of culms in a clump and the number of dry bamboos is considerably increased and both these factors lower the profit to a lower extent. What is gained by a comparatively high price from a smaller outturn of bamboos (giving only a higher percentage sale value) consequent upon reduced supply is lost in incurring heavy expenditure in working the congested clumps extracting dry (economically useless) bamboos. Lengthening of the felling cycle to effect a reduction in the outturn is tantamount to suspension of fellings over a large area and any one conversant with bamboo working knows too well the baneful effects of such a system and the expense and supervision on cleaning operations before the clumps can again be brought into a normal condition.

The following statement shows the number of bamboos sold from 1909-10 to 1930-31 from Karnpur and Bindraban forests :—

Year.	Number sold.	Year.	Number sold.
1909-10	488,966	1920-21	689,175
1910-11	372,713	1921-22	539,545
1911-12	654,614	1922-23	689,583
1912-13	446,222	1923-24	540,189
1913-14	423,162	1924-25	537,475
1914-15	212,027	1925-26	566,867
1915-16	563,423	1926-27	518,229
1916-17	627,981	1927-28	211,268
1917-18	1,145,003	1928-29	254,989
1918-19	1,229,067	1929-30	261,574
1919-20	880,290	1930-31	193,035

Is the inference that the figures quoted above represent the silvicultural outturn correct? Every forest officer who has been in charge of the felling operations will most strongly assert that fellings in his time were made on correct silvicultural lines; but the condition of the clumps in 1927-28, when I was in charge of Hoshiarpur Forest Division, showed that very heavy fellings had been the rule rather than the exception. With the introduction of conservative felling rules and strict supervision of the felling work, outturn was automatically reduced to less than one half of what was obtained in the immediate past. Emphasis may be laid on the fact that this was accomplished without any change in the felling cycle and though the fellings were somewhat heavier than I would have wished to see, the improvement in the condition of the clumps was remarkable.

6. To sum up, the felling cycle cannot be determined by the age at which a culm matures. Maturity of a culm has reference to the rotation. Only the production figures of sample plots, even if reliable, are not the final test; it is necessary to determine the number and class of the marketable bamboos, to deduct the expense in the extraction of useless and dry bamboos and to compare the condition of the clumps at the close of the experiment. Without knowing the true silvicultural outturn of a forest and the rate of dying of bamboos, it is unsafe to lengthen the felling cycle to effect a reduction in the yield.

7. It would be instructive to examine the data from another sample plot which was laid out at the same time as Karnpur—sample plot No. 1 in Reserve Dhamtal of Kangra Forest Division. The following statement compares the production of new shoots and their sizes under the three felling cycles:—

Felling Cycle.	No. of culms at the commencement.	Production in 6 years.				Total.	Increase per cent.
		Kalan.	*Khurd.*	*Sota.*	Useless.		
1 year ...	206	33	260	120	22	435	111
2 years ...	208	60	321	89	49	519	150
3 years ...	232	34	313	63	20	430	85

Under annual cutting the number of shoots increased by 111 per cent., under a two years felling cycle the increase was by 150 per cent., while in the clumps under a three years felling cycle the shoots increased by 85 per cent. Clumps under the biennial felling cycle gave the largest number of *kalan* and *khurd* bamboos, while the number of *sotas* produced was greatest under the annual felling cycle and it was least under the triennial rotation.

The sub-joined table compares the number and the classes felled :—

Felling Cycle.	Number felled.				Total.
	Kalan.	*Khurd.*	*Sota.*	Useless.	
1 year	45	160	89	50	344
2 years	48	188	60	70	366
3 years	39	182	42	89	352

It will be seen that the biennial felling cycles gave the maximum yield both in numbers and superior classes. It is, however, necessary to compare the money yield to realise the significance of the various classes and to eliminate the expenditure on cutting the useless bamboos and the following figures based on the average price of bamboos of various classes, less the expenditure incurred on cutting useless bamboos, compare the profit accumulated at 4 per cent. per annum, the totals giving the position at the close of the experiment :—

Year.	1 year felling cycle.	2 years felling cycle.	3 years felling cycle.
1916-17 ...	Rs. 2·31 × 1·217 = 2·81	...	...
1917-18 ...	,, 1·45 × 1·17 = 1·70	2·47 × 1·17 = 2·89	...
1918-19 ...	,, ·68 × 1·125 = ·77	...	2·67 × 1·125 = 3·00
1919-20 ...	,, 1·47 × 1·082 = 1·59	2·67 × 1·082 = 2·89	...
1920-21 ...	,, 1·78 × 1·04 = 1·85	...	...
1921-22 ...	,, 1·95 = 1·95	4·92 = 4·92	5·81 = 5·81
Total ...	10·67	10·70	8·81

The highest money yield was obtained under the biennial felling cycle.

At the close of the experiment it was noticed that the clumps worked under the triennial felling cycle had become congested, while those of 1 year felling cycle had become too open. From the statements given above it will be seen that the number of culms under clumps of different felling cycles was 297, 361 and 310 respectively at the end of the experiment. Congestion in the latter indicates the fact that the new shoots did not develop at the periphery of the clump, but arose somewhere in the clump, thus resulting in congestion. On the other hand clumps under the biennial felling cycle, inspite of their containing the largest number of shoots did not exhibit signs of either congestion or openness. The results of the Dhamtal sample plot observations establish the soundness of a biennial felling cycle, but the data for the first three years are vitiated by the mechanical fellings prescribed [*vide* rule (vi) in paragraph 4 supra], though the fellings during the last three years were silvicultural.

8. The analogy of the selection forest to a bamboo clump leads to the necessity of determining the rotation and the felling cycle. In a high forest worked under the selection system the exploitable size or the age or both are determinate factors in arriving at a correct fixation of the rotation; but in the case of bamboos the conditions are peculiar. Size of a culm is not an indication of age. The age of a culm cannot be accurately determined, though the following changes can be generally discerned as the culm progresses in age. The ages are supposed to be taken in October:—

Manus—Produced during the rainy season, are in reality three months old; bracts tightly envelope the culm which has a thick coating of white downy pubescence.

1 year old shoots—Are in reality one year and three months old; bracts have generally fallen though some

remain attached to the nodes; they are generally dry: the pubescence has disappeared from the middle of the interriote which becomes glaucous green while some is present near the modes.

2 years old shoots—Are in reality 2 years and 3 months old; culm becomes harder and less pliant; all bracts have disappeared and no pubescence is visible; greater part of the culm is uniformly green.

Generally the above changes can be seen in the majority of cases, yet it is not infrequent to make mistakes. After the first 27 months even a rough determination of the age is not possible though the following changes can be traced:—

(*a*) The culm becomes dark green and big black blotches or spots (which can be rubbed away in many cases) appear on it. Big dark blotches are an unfailing sign of approaching overmaturity. This stage may, however, be absent on hot and dry slopes.

(*b*) Yellow spots appear over different parts of the culm. The culm has now become overmature and thus useless for export.

(*c*) Yellow patches spread and the greater part of the culm becomes yellowish, while grey spots, harbinger of dryness, make their appearance. The culm becomes completely grey and dry and has then no economic value.

In some cases culms two years old become yellowish and dry, though the majority can be generally seen to pass through the above stages. Apparently the rotation should correspond to the age when the colour of the culm becomes dark green and dark blotches appear on it. This stage can be easily recognised, but its corresponding age cannot be established. The following figures compiled from the Karnpur sample plots for the period

1922-23 to 1930-31 show the intensity of fellings over various age classes :—

Age.	SAMPLE PLOT NO. 1. Felling Cycle.			SAMPLE PLOT NO. 3. Felling Cycle.		
	1 year.	2 years.	3 years.	1 year.	2 years.	3 years.
Over 6 years	67·0%	77·9%	90·0%	85·9%	85·8%	93·3%
5 "	7·4%	3·8%	3·3%	5·1%	7·4%	·5%
4 "	9·2%	5·1%	3·3%	2·0%	2·0%	1·6%
3 "	7·4%	8·1%	2·6%	3·0%	1·5%	2·6%
2 "	5·9%	3·4%	·4%	2·0%	1·4%	1·0%
1 "	·7%	1·7%	...	1·5%	·4%	1·0%
Manus	2·4%	...	·4%	·5%	1·5%	...
Percentage of dry bamboos felled.	19%	35%	41%	9%	17%	19%

Fellings are principally restricted to culms over 5 years old. Rotation can, therefore, be taken to be over 5 years.

9. The felling cycle is based on the following factors :—

(*a*) Intensity of management and the degree of supervision possible.

(*b*) The age at which the bamboos begin to dry or, in other words, the age at which they become overmature.

(*c*) The congestion of the clumps resulting from fellings under different felling cycles and consequent difficulties and increased expenditure in working a clump.

(*d*) The stage which the rhizome has reached in its life cycle.

(*e*) Local races.

Each factor is dealt with seriatim below :—

(*a*) *Intensity of management.*—The ideal arrangement is to have fellings all over the area every year. The cultural operations and cleanings have full play and the whole forest is kept in an

ideal condition; but the disadvantage is that the work is scattered over a large area and intensive supervision, which is an indispensable factor, is almost impossible. Annual fellings are, therefore, generally impracticable. The difficulty of supervision in a two years felling cycle as compared with a triennial felling cycle is, however, more imaginary than real. Three years felling cycle results in congestion and to make silvicultural fellings, cleanings are a preliminary necessity which result in the scattering of the work and add to the difficulties of supervision.

(*b*) *The age at which culms become overmature.*—It has been shown above that culms over 5 years old become dry. The felling cycle must be, therefore, less than 5 years.

The last line in the statement in the preceding paragraph shows the largest percentage of dry bamboos under the triennial felling cycle, while under the annual felling cycle the number of dry bamboos removed is the smallest. It may, therefore, be inferred that longer the felling cycle the larger will be the proportion of dry bamboos, the felling of which is silviculturally necessary, but economically unrenumerative, if not definitely expensive. The expensive cleaning operations necessitated in the bamboo forests are a direct result of lack of working. Even on hot aspects, the percentage of dry bamboos is greater in culms worked under a triennial felling cycle (*vide* figures for Karnpur sample plot 3).

(*c*) *The congestion of the clump.*—The longer the felling cycle the greater the congestion and the higher the expenditure on working. Dhamtal sample plot figures clearly point to the higher money yield under a biennial felling cycle rather than under a three years felling cycle.

(*d*) *The age of the rhizome.*—In laying out a sample plot to determine the felling cycle it is not only necessary to create uniform conditions for all the clumps under observation, but it is also obligatory to see that the various clumps under the different felling cycles have as close a resemblance as possible with regard to their age. Bamboo is a perennial grass; its life cycle begins with its regeneration and ends when the clump flowers. The

rhizomes of different clumps may be of different ages. The production and longevity of culms depends to a great extent on the vigour (which in its terms depends on the age) of the rhizome. Judged from this point of view similarity of conditions was not ensured in the sample plots discussed in this article; nor is it easy to do so on account of the difficulty of finding the correct age of the rhizome.

Associated with the age of the rhizome is the size of the clump. For a true comparison the clumps under different felling cycles should be equal in size and in the whole of their life the culms are absorbing through their leaves nutritive material which they cannot use themselves and which they must therefore be passing to the rhizomes. The more shoots there are on the clump, the better should be the nutrition of the rhizome unless the physiological activity is affected by a limiting factor *e.g.*, deficient moisture, etc.

(*e*) *Local races.*—The question of local races has not received the attention it deserves. The five bamboo forests in Kangra and Hoshiarpur Divisions yield different bamboos of different kinds and qualities and the observations in one forest may not be strictly applicable to the other.

10. Assuming that the sample plot figures are inapplicable, it has to be determined whether the felling cycle requires to be changed or the felling rules. It will, I hope, be conceded that the average annual production of shoots is not more than 10 per cent. of the number in an individual clump. Supposing the existing number of bamboos in a clump after fellings is E, the number in that clump at the time of the next felling will be as under :—

In December 1930, after the fellings, the number is E.

By December 1931, 10 per cent. new shoots are added and the number thus becomes $\frac{E+E}{10}$ or $\frac{11+E}{10}$.

By December 1932, 10 per cent. new shoots are added and the number thus becomes $\frac{11+E}{10} + \frac{11+E}{100}$ or $\frac{121+E}{100}$.

By October 1933, 10 per cent. more has been added and the total becomes $\frac{121+E}{100} + \frac{121+E}{1000}$ or $\frac{1331+E}{1000}$ or 1·33 E.

The clump containing 1·33 E shoots is composed of culms of the following ages:—

E.—This was the number left after the 1930 fellings; some shoots are three years old, others are four years old and others more than four years old.

·33.—This represents the new production. The ages of the shoots are two years, one year and less than one year.

Under the existing felling rules the cutting will be restricted to E, of which half is removable under the rules. But it is necessary here to take into consideration two important factors. On suitable localities the clumps would have become congested while in more exposed situations drying of bamboos is quickened and many of the E bamboos older than four years would have become dry. In actual practice, therefore, more than 50 per cent. of the E bamboos would have been removed. This means the clump becomes more open as:—

$$1{\cdot}33\ E - {\cdot}50\ E = {\cdot}83\ E.$$

It follows that unless the production in three years equals 50 per cent. of the existing number of the shoots, mere lengthening of the cycle cannot result in the improvement of the clumps. The production of new shoots is not uniform. It is primarily determined by rainfall, which varies from year to year. A fixed felling cycle introduces a rigidity which cannot take into account this important variation. The remedy is to be looked for elsewhere and it will be shown hereafter that felling rules can be so designed as to permit of sufficient elasticity.

11. The incompleteness of our knowledge about the biology of bamboo necessitates concentration on the felling rules.

The gross increment in a bamboo forest is the total number of new shoots produced in a year. The net increment is the gross increment, less the loss through decay, malformation and all agencies of destruction other than human utilisation. In a virgin forest the gross increment may be considerable, but the net increment is nil as the decay is equal to the new production. Net increment only becomes possible when human utilisation is introduced, for the bamboos which would have otherwise rotted are

removed and this reduces the number lost through dryage, etc. Human utilisation thus increases the net increment.

When fellings first started in the bamboo forests the number felled was bound to exceed the net increment because the net increment was nil. Net increment could not provide a test of the number which may have been justifiably removed and apparently the gross increment was taken into consideration when 50 per cent. removal was prescribed, it being assumed that the production was 20—25 per cent. per annum. If through proper management, malformation and drying of bamboos could have been eliminated the net increment would have become equal to the gross increment and no harm would have resulted by removing each year the number equal to the gross increment. But in practice the gross increment has fallen and the fellings have not taken into consideration the new production, though efforts have been made to reduce the decay factors by cleanings. If the productivity of the forest is to be maintained, the new shoots must be protected and tended in the cut over areas and the net increment should form a guide to the number that may be annually removed.

12. Judged from these considerations the old felling rules were quite correct as they dealt with more or less virgin forests, but it would be unsafe to apply them now. The maximum number of bamboos that can now be felled from a clump should not exceed the number produced in two preceding seasons. *Manus* and first year shoots are easily distinguished but beyond the first year correct determination of age is not feasible. The total production of the two seasons represents the gross increment and fellings should be based on the actual increment. If this is done no possibility of over felling can arise. To reduce the gross increment to the net increment the following restrictions are suggested :—

(*a*) The shoots left are uniformly distributed over the support.

(*b*) The young shoots are provided with sufficient support.

(*c*) No side cutting or cutting through the clump is permissible.

(*d*) First or second year shoots are not to be cut under any circumstances.

(*e*) All old culms in a clump are not felled.

With these restrictions the number felled from each clump will be less than the gross increment and the condition of the clumps will undoubtedly improve.

From management point of view biennial felling cycle has not caused any serious difficulties and a change in the felling cycle is unnecessary.

KARNPUR SAMPLE PLOT NO. 1.

Annual Felling Cycle.

Year in which fellings were due.			1919-20.	1920-21.	1921-22.	1922-23.	1923-24.	1924-25.	1925-26.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.
			F	F	F	F	F	F	F	F	F	F	F	F
Clump No.	1	...	F	F	F	F	F	...	F	F	F	F	F	F
,,	4	...	F	F	F	F	F	...	F	F	F	F	F	F
,,	7	...	...	F	F	F	F	...	F	...	F	F	F	F
,,	10	...	...	F	...	F	F	...	F	...	F	F	F	...
,,	13	...	F	F	F	F	F	...	F	F	F	F	F	...
,,	16	...	F	F	F	F	F	...	F	F	F	F	F	F
,,	19	...	F	F	F	F	F	...	F	F	F	F	F	F
,,	22	...	F	F	F	F	F	...	F	...	F	F	F	F
,,	25	...	...	F	F	F	F	...	...	...	F	F	F	...
,,	28	...	F	F	F	F	F	...	F	F	F	F	F	F
,,	31	..	F	F	F	F	...	...	F	F	F	F	F	F
,,	34	...	F	F	F	F	F	..	F	...	F	F	F	F

NOTE :—F in the first line denotes the year in which fellings were due ; elsewhere the year of actual felling.

KARNPUR SAMPLE PLOT No. 1.

2 Years Felling Cycle.

Year in which fellings were due.	1919-20.	1920-21.	1921-22.	1922-23.	1923-24.	1924-25.	1925-26.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.
	F	...	F	...	F	...	F	...	F	...	F	...
Clump No. 2 ...	...	...	F	...	...	F	F	...	F	...	F	...
" 5 ...	...	F	...	...	F	...	F	...	F	..	F	F
" 8 ...	...	F	...	...	F	...	F	...	F	...	F	...
" 11 ...	...	F	...	...	F	...	F	...	F	...	F	...
" 14 ...	...	F	...	...	F	...	F	...	F	...	F	F
" 17 ...	...	F	...	...	F	...	...	.	F	...	F	...
" 20 ...	...	F	F	...	...	F	...	F	...	...	F	...
" 23 ...	...	F	F	...	...	F	...	F	F	...	F	...
" 26 ...	...	F	F	...	...	F	...	...	F	...	F	...
" 29 ...	...	F	...	F	...	F	...	F	...	...	F	...
" 32 ...	...	P	...	...	...	F	...	F	...	...	F	F
" 35 ...	...	F	F	...	...	F	...	F	...	...	F	...

NOTE :—F in the first line denotes the year in which fellings were due ; elsewhere the year of actual felling.

KARNPUR SAMPLE PLOT No. 1.

3 Years Felling Cycle.

Year in which fellings were due.	1919-20.	1920-21	1921-22	1922-23.	1923-24.	1924-25.	1925-26.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.
	F	..	...	F	...	...	F	...	...	F	...	..
Clump No. 3 ...	...	...	F	...	...	F	...	F	...	...	F	...
" 6 ...	...	...	F	...	...	F	...	...	F	...	F	...
" 9 ...	...	...	F	...	...	F	...	...	F	...	F	...
" 12 ...	...	...	F	...	...	F	...	...	F	...	F	...
" 15 ...	...	...	F	...	...	F	...	...	F	...	F	..
" 18 ...	...	..	F	...	.	F	...	...	F	...	F	...
" 21 ...	...	.	F	...	...	F	...	...	F	...	F	...
" 24 ...	...	...	F	...	...	F	...	...	F	...	F	...
" 27 .	...	...	F	...	...	F	...	...	F	...	F	...
" 30 ...	...	...	F	...	...	F	...	...	F	...	...	.
" 33 ...	...	...	...	...	...	F	...	...	F	...	F	...
" 36 ...	...	...	...	...	...	F	...	...	F	...	F	...

NOTE :—F in the first line denotes the year in which fellings were due ; elsewhere the year of actual felling.

KARNPUR SAMPLE PLOT No. 3.

Annual Felling Cycle.

Year in which fellings were due.	1919-20.	192-021.	1921-22.	1922-23.	1923-24	1924-25.	1925-26.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.
	F	F	F	F	F	F	F	F	F	F	F	F
Clump No. 1 ...	F	F	F	F	F	...	F	F	...	...	...	F
" 4 ...	F	F	F	F	F	...	F	F	F	F	F	...
" 7 ...	F	F	F	F	F	...	F	F	F	F	F	F
" 10 ...	F	F	F	F	F	...	F	..	F	F	...	...
" 13 ...	F	F	F	F	F	...	F	...	F	...	...	...
" 16 ...	F	F	F	F	F	...	F	F	F	F	...	...
" 19 ...	F	F	F	F	F	...	F	F	F	F	...	...
" 22 ...	F	F	...	F	F	...	F	F	...	F	...	...
" 25 ...	F	F	F	F	F	...	F	F	F	F	...	...
" 28 ...	F	F	F	F	F	...	F	F	F	F	F	F

NOTE :—F in the first line denotes the year in which fellings were due ; elsewhere the year of actual felling.

KARNPUR SAMPLE PLOT No. 3.

2 *Years Felling Cycle.*

Year in which fellings were due.	1919-20.	1920-21.	1921-22.	1922-23.	1923-24.	1924-25.	1925-26.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.
	...	F	...	F	...	F	...	F	...	F	...	F
Clump No. 2 ..	...	F	...	F	...	...	F	...	F	...	F	F
,, 5 ...	...	F	...	...	F	...	F	...	F	...	F	...
,, 8 ...	...	F	...	...	F	...	F	...	F	...	...	...
,, 11 ...	...	F	F	...	...	F	...	F	F	...	...	...
,, 14 ...	...	F	...	...	...	F	...	F	...	...	F	...
,, 17 ...	...	F	...	...	F	...	F	...	...	...	...	...
,, 20 ...	...	F	...	...	F	...	F	...	F	...	...	F
,, 23 ...	...	F	...	...	F	...	F	...	F	...	F	F
,, 26 ...	...	F	...	...	F	...	F	...	F	...	F	...
,, 29 ..	...	F	...	...	F	...	F	...	F	...	...	...

NOTE :—F in the first line denotes the year in which fellings were due ; elsewhere the year of actual felling.

KARNPUR SAMPLE PLOT No. 3.

3 Years Felling Cycle.

		1919-20.	1920-21.	1921-22.	1922-23.	1923-24.	1924-25.	1925-26.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.
Year in which fellings were due.		...	...	F	...	...	F	...	...	F	...	...	F
Clump No. 3	...	...	...	F	...	...	F	...	...	F	...	F	...
„ 6	...	...	...	F	...	...	F	...	...	F	...	F	...
„ 9	...	...	...	F	...	...	F	...	...	F	...	...	...
„ 12	...	...	...	F	...	...	F	...	...	F	...	F	
„ 15	...	...	...	F	...	...	F	...	...	F	..	...	...
„ 18	...	...	...	F	...	...	F	...	...	F	...	F	...
„ 21	...	...	...	F	...	...	F	...	...	F	...	F	...
„ 24	...	...	...	F	...	...	F	...	...	F	...	F	F
„ 27	...	...	...	F	...		F	...	...	F	...	F	...
„ 30	...	...	...	F	...	...	F	...	...		...	F	...

NOTE :—F in the first line denotes the year in which fellings were due ; elsewhere the year of actual felling.

ARTIFICIAL REGENERATION OF 1921 BURNT AREAS IN THE WESTERN HIMALAYAS.

BY P. N. DEOGAN, P.F.S.

An article by P. Kailash Chander appeared in the *Indian Forester*, March, 1931, under this heading.

The present note is intended to describe a new method of debris disposal in the hope that it may be useful to those employed on the afforesting of such burnt areas. To form an idea of these burnt areas one may imagine a two-storied forest with dry (burnt) trees and poles of *kail* (*Pinus excelsa*) forming the upper storey, and shrubs and saplings of *Coriaria*, *Rubus*, *Poplars*, etc. forming the lower one. In addition to these there is a ground cover of various grasses and ferns. In certain areas *kail* (*Pinus excelsa*) has sprung up naturally, and such areas, if sufficiently well stocked, are excluded from the regeneration operations since it would only be a waste of money to clear them and re-stock them with deodar at considerable expense.

The amount of stuff on these burnt areas which has to be cleared before doing any regeneration work is enormous, and its disposal is the chief problem.

To say, "cut all dry standing trees and all bushy growth that has sprung up during the last 8 years, burn them broadcast, hoe up the soil and scatter the seed" (*vide* Chandra's article) is all very well, but is as impracticable as anything could be. No broadcast fire will burn the stuff as completely as desired and certainly not in the period October-November. The only method that has commonly been used is to cut all dry standing trees and bushes and stack them into heaps after billetting. This was found very expensive and so the following method was evolved in collaboration with Mr. H. S. Deans, Deputy Conservator of Forests.

A line about 10′—15′ wide is cut round the area to be taken up for regeneration. In the month of June (when it is very hot and everything is easy to burn) fire is let into the area. This results in crumpling down all the weaker trees and bushes. The

area is left alone and during the rains a number of the standing trees come down, those still standing being easier to fell after the fire.

The trees that persist after the rains are felled and heaped as follows :—

Each whole log or tree is lifted by one end and tipped in line in heaps of 4—8 trees, as the case may be, along or across the contours. This sort of stacking gives the appearance of chess-board if viewed from a distance. Two to four men are generally enough to tilt a tree or a log in the position required. No billetting or cutting up into fuel wood is allowed. This method of stacking, as compared to billetting and stacking in heaps, is much easier than can be imagined or described, and results in an appreciable saving.

Any small brushwood that may be in the area is cut and thrown over these heaps. Fire is let into these after a few days, about the last week of November, which consumes the stuff more or less completely. It does not matter if a few large trees which may have been burned or scorched are left over.

Deodar seed is sown broadcast in or about the second week of November after raking up the soil lightly. This gets covered with the winter snow and in the next spring one can see the beautiful green cover of deodar. It is generally considered inadvisable to aim at pure plantations of deodar. Any mixture is welcome. In places where there are a few *kail* trees in the vicinity, *kail* comes in naturally ; otherwise it is a good plan to introduce some oaks and *kail* artificially. Balara plantation in Lower Bashahr Forest Division was created by the writer mostly on these lines. The last report on this plantation by one of the Punjab Conservators summarises the results :—

"........Plantation in excellent order and reflects great credit on the staff and cost only Rs. 2-8-0 per acre." This cost is the average for the whole plantation which includes portions done by transplanting, but the cost for broadcast sowings (inclusive of debris disposal) works up to Rs. 9-12-0 per acre. After eighteen

months plants as big as 18″ were measured and on the average the plantation was 12″ high.

It may be added that raising of field crops was tried departmentally before putting out deodar in Bijashal and Kiuli plantations of Lower Bashahr Division in 1923-24; but the Department instead of making some revenue lost thereby.

In 1928, an area of about 8 acres was burnt and trees cut and stacked as described above. The area was let out to a cultivator who agreed to burn the stacks after cutting up the bushy growth and also to hand over one-third of the produce to the Forest Department. To begin with the crop was plentiful, but later on bears got in and within a few days the greater portion of the crop was destroyed. All the same the Department did not actually lose. Some cash was received by the sale of the field crop and at the same time the area which had been cleared of all trees and bushes was taken over for the sowings of deodar seed (*i.e.*, in the end of October).

If this system of letting out the area for cultivation is tried, it would be better to have potatoes or some leguminous crop for sowings before deodar. The digging up of the potatoes loosens the soil and any leguminous crop will enrich the soil.

EDITORIAL.

APPOINTMENT OF LT.-COL. L. N. SEAMAN AS A.D.C. TO H.E. THE GOVERNOR OF THE UNITED PROVINCES.

We offer our congratulations to Lieutenant-Colonel L. N. Seaman, Dehra Dun Contingent, Auxiliary Force (India), Officer-in-charge of the Timber Testing Section of the Forest Research Institute, Dehra Dun, on his recent appointment as Honorary Aide-de-Camp on the personal staff of His Excellency the Governor of the United Provinces of Agra and Oudh, *vice* Lieutenant-Colonel V. W. H. Duke, O.B.E., M.C., resigned.

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DIGITALIS CULTIVATION IN KASHMIR.

BY H. L. WRIGHT, I.F.S., CHIEF CONSERVATOR OF FORESTS, JAMMU AND KASHMIR.

The common English foxglove (*Digitalis purpurea*) is a plant of considerable medicinal value, its leaves being the source of digitalin, a drug commonly used in the form of a tincture in affections of the heart. At one time it was thought that only the wild leaves had the desired efficacy, but since it has been known that cultivated leaves are equally successful, attempts have been made to grow the foxglove as a crop in various parts of the world. In Hungary it is cultivated on a large scale, the whole industry being under Government supervision. In India, *Digitalis* is nowhere indigenous, but it has been introduced successfully in various places.

The earliest attempts to grow it as a regular crop for medicinal purposes appear to have been made as early as 1880 in the Government gardens at Saharanpur and in hill gardens at Mussoorie. The plant, however, did not flourish, and it was reported to yield very few leaves, while the cost of production was higher than that of the imported leaves. In Kumaon gardens it did better, and leaves from there, chemically examined in 1912, were found to be well above the standard. The plant was cultivated on a commercial scale in several places, notably Mungpoo, near Darjeeling and in the Nilgiri hills. It was also grown as a garden plant in Kashmir.

In 1925, investigations carried out at the School of Tropical Medicine, Calcutta, on leaves obtained from various localities in India, showed that leaves grown in Kashmir and Mungpoo were of good quality, while those grown in the Nilgiris were not so good. The Kashmir leaves were markedly the best and were, in fact, as good as the best leaf available from Europe. It was further demonstrated that tinctures of digitalis, even when manufactured by the most reliable firms, are, when imported into India, affected by the climate, and lose from 20 to 40 per cent. of their potency in a very short time. It is very desirable, therefore, that for use in India, freshly prepared tincture should be available from local manufacturers, but this is not possible without an assured and regular supply of indigenous leaves.

The excellence of the Kashmir leaves having been demonstrated, the Kashmir Forest Department decided to endeavour to grow foxglove as a crop on a commercial scale. A start was made in 1926, but was limited by the small amount of seed available. A nursery was laid down at Tangmarg, at about 7,000 feet elevation, and proved very successful. The plants flower in their second year, and from 1928 onwards ample seed has been available and cultivation has been extended to other parts of Kashmir and to several places in Jammu.

The climate of Kashmir appears to be admirably suitable for the growth of digitalis, for it can be grown without difficulty in almost any suitable locality at an elevation of from 5,000 to 7,000 feet. It requires good soil and prefers a light overhead shade. Seeds are sown in nursery beds early in the spring and germinate in two or three weeks. By July or August the seedlings are big enough to put out and are usually planted a foot apart. Flowers begin to appear during the latter half of May, but in some places are to be found as late as September. Cutting back the flower shoot appears to stimulate leaf production, so only those plants are allowed to flower which are required for seed.

Plucking commences just before flowering, and continues at intervals all through the summer, the last plucking being in late autumn. First year's leaves are not ordinarily gathered, though

these have the same glucoside content as those of the second year. Each collection is spread out in thin layers to dry and the leaves are turned over periodically to prevent fermentation. Considerable loss occurs in drying, the dry weight being rather less than 30 per cent. of the weight of the green leaves. In Kashmir it is possible to dry the leaves without the aid of an oven, which is a distinct advantage, as oven-drying has been shown to cause marked deterioration, especially if the temperature is allowed to run high.

After drying the leaves are sent to the Forest Department's central minor products godowns at Baramula, where they are carefully cleaned and packed in wooden boxes for export. The annual demand for digitalis leaves in India is said to be about five tons, and there is every hope of Kashmir being able to meet the greater part of this demand within the next few years. Once nurseries are established, the cost of growing, plucking, drying and transport to Baramula should not exceed Rs. 15 per maund, and as at present there is a ready demand for leaves at about Rs. 60 per maund, considerable profit is obtainable.

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THE NATURAL REGENERATION OF SILVER FIR (ABIES PINDROW).

BY A. E. OSMASTON, I.F.S., PRINCIPAL, FOREST COLLEGE, DEHRA DUN.

Much attention has been focussed of recent years on the natural regeneration of silver fir in the Punjab.

Nearly all writers stress the harmful effect of a dense layer of partly raw humus. This was emphasised by Troup (1.—page 1138) who mentions among the chief requirements for successful reproduction, a newly exposed mineral soil and an absence of sour humus or excessive soil moisture. Trevor (2.—para: 188) says that an excessive deposit of needles is inimical to the regeneration of all coniferous trees, and that though seed germinates readily in this loose humus, the seedlings cannot survive the hot weather in May and June. The same writer (3.—page 269) concludes that excessive humus is largely responsible for the failure of fir reproduction where grazing and insufficient light are not contributory causes. Messrs. Parnell, Glover and Deans (4) all emphasise this aspect. The former thinks it possible that the complete removal of the sour undecayed humus would enable silver fir seedlings to establish themselves even in the fullest light. This is almost exactly what has happened in several patches scraped clean of humus for the sake of obtaining blue pine regeneration in the Kalga block, Kulu, where natural silver fir regeneration has appeared in quantities, though not with complete overhead light. The note by Deans is in my opinion of special interest. He found that in silver fir forests the humus layer was seldom less than 10″ deep, and he had noticed it up to 18″ deep. A similar depth was also noticed by me in a forest above Pulga. Commenting on the negative results of certain regeneration experiments started in 1922 in Lower Bashahr he remarks that in all these experimental plots the humus layer is still 9″ to 12″ deep, except in a few patches where seedlings (spruce) have appeared. He further mentions an instance which came under his observation in *karshu* oak (*Quercus semecarpifolia*) forest where there was plentiful silver fir regeneration with a humus depth up to a maximum of 2″.

These references are sufficient to show the general consensus of opinion among Forest Officers, namely that excessive humus is one, and probably the principal, reason for the absence of silver fir regeneration, provided sheep and goats are excluded. The only contrary opinion that I have seen is expressed by

Flewett (4) who says that given overhead shade he does not think the existence of humus in itself sufficient to hinder regeneration.

The necessity for some degree of shade is generally admitted by all. Parma Nand and Wright (5) on page 44 affirm that both spruce and silver fir germinate under all conditions of light and shade. Other writers have modified views, but it seems clear that light conditions are of secondary importance, provided at least a little shade is given.

An interesting observation is recorded by Flewett (4) who mentions a case in which silver fir saplings had successfully established themselves in an old undecomposed log. Parma Nand and Wright (5) also say that seedlings have been observed on rotten stumps and in crevices in the bark of fallen and standing trees. I personally came across two similar examples in virgin silver fir forest in the Kukas block, Kulu, at about 9,500′ elevation. In both instances silver fir seedlings had completely established themselves on a half-decomposed log in forest of considerable density, whilst the absence of regeneration all around was most marked. In one example the log was surrounded by a dense growth of *Strobilanthes atropurpureus*; in the other, by a fairly dense weed growth of species other than *Strobilanthes.* Similar results have been observed in spruce forests both on the Continent and in America. Eide (7) attributes the occurrence of seedlings on rotten wood to a combination of factors, such as soil moisture, soil temperature, and nitrogen formation. Henrik Hesselman in part supports this view when he states that rotten timber produces nitrification in the ground even in circumstances in which the formation of nitrates does not normally occur. Mork (8) suggests that it is due to the abundance of mycorhiza in the decaying wood. Barr (6) on the other hand shows that rotten wood has a very high moisture content even in dry weather and considers this sufficient reason for the germination and survival of the seedlings. Whatever the true reason may be, its discovery is likely to throw valuable light on the problem of the natural regeneration of silver fir and spruce and is, therefore, worth careful investigation.

A few writers have attempted to correlate the flora of shrubs and herbs in the Himalayan coniferous forests with the presence or absence of regeneration. Thus Glover (4) considers that favourable conditions for silver fir regeneration are indicated by maiden hair fern, Aaron's rod, violet and strawberry, and definitely unfavourable conditions by *Strobilanthes* and the shade-bearing balsams. Again Gorrie (9) says *Thalictrum* (referring to the three species *minus*, *javanicum* and *foliolosum*) can be taken as a fairly reliable indication that soil and light conditions are favourable for deodar reproduction. He considers its occurrence in the middle deodar zone in any large quantities and in conjunction with *Fragaria vesca*, *Valeriana wallichii*, *Viola* spp. and *Indigofera* shows that deodar may safely be opened up under regular shelterwood markings. I have recently made some further observations on these lines combined with data regarding the average depth of humus, and it is the results of these observations which I give below.

My observations were carried out during the first week of May 1931 and were confined to section 4 of Kalga compartment in the Parbatti range, Kulu division. This compartment contains excellent natural regeneration of silver fir, most of which is under 12 years old. The sub-soil is gneiss; the aspect north-east to north-west and the altitudinal limits within which observations were made, 8,500′ and 9,500′. The gradients are fairly steep and average 30° to 35°. Previous to 1916, the forest was a mixed crop of silver fir, blue pine and spruce, in which blue pine predominated, and the quality of the forest was excellent. Shelterwood regeneration fellings were started in 1916. In 1928 secondary fellings were made, leaving 8—12 seed-bearers per acre. In this operation many silver fir as well as blue pine were removed, leaving a shelterwood mainly composed of blue pine, since silver fir natural regeneration was already present on the ground in fair quantities, whereas blue pine regeneration was very deficient. Felling refuse was burnt after both primary and secondary fellings, bush cutting was carried out at frequent intervals and, needless to say, the area was closed to grazing.

I selected for examination ten plots containing good natural silver fir regeneration varying up to 10 years old, though most of it was younger, and all plots contained quite younger seedlings as well as older plants. Each plot covered an area of about 15 x 15 feet, though no limits were actually laid out. The frequency of species was estimated by eye only, and it is important to emphasise the fact that several species have doubtless been overlooked as, at this time of year, some plants are only just commencing to germinate or, as in the case of some balsams, have not germinated at all. For the same reason the frequency was probably not very accurately judged for those species only showing small shoots, and even the correct identification was a matter of considerable difficulty so that this also cannot be regarded as free from possible inaccuracies.

The average depth of humus obtained by making at least three observations in each plot varied for any one plot between 2 and 3 inches, and the absolute limits of any single observation were $\frac{1}{2}$ and 5 inches. The average depth in all 10 plots together was 2·25″.

In the following list of species observed—v.a = very abundant (5); a = abundant (4); f = frequent (3); o = occasional (2); r = rare (1); the number in brackets representing the value given to each degree of frequency. In recording constancy, presence in 9 or 10 plots is denoted by the figure 5; presence in 7 or 8 plots by the figure 4, and so on. Presence in all ten plots is shown by placing the 5 in brackets.

A. Characteristic Species.

	Frequency.	Constancy.
1. *Fragaria vesca*	4·9	(5)
2. Moss	3·1	(5)
3. *Solidago virga-aurea* ...	2·8	(5)
4. Grass	1·7	(5)
5. *Indigofera gerardiana* ...	2·8	5
6. *Smilax vaginata* ...	2·0	5
7. *Ainsliæa aptera* ...	1·2	5

		Frequency.	Constancy.
8. *Anaphalis cinnamomea*	...	2·0	4
9. *Galium asperifolium*	...	1·1	4
10. *Valeriana wallichii*	...	1·2	2

B. SPECIES NOT CHARACTERISTIC.

(*i*) Herbs.—

11. *Adiantum venustum**	...	·8	2
12. *Oxalis acetosella*	...	·7	2
13. *Polygonum (amplexicaule ?)*	...	·6	2
14. *Mertensia racemosa**	...	·6	2
15. *Thalictrum* sp.* ...	...	·5	2
16. *Viola serpens* ...	...	·4	2
17. *Ranunculus* sp. ...	...	·2	2
18. Ferns (*Aspidium ?*)	...	·4	3
19. *Strobilanthes atropurpureus*	...	·5	1
20. *Smilacina pallida*	...	·4	1
21. *Senecio rufinervis**	...	·4	1
22. *Bupleurum* sp.* ...	...	·3	1
23. *Primula denticulata*	...	·2	1
24. *Strobilanthes wallichii*	...	·2	1
25. *Trillium govanianum*	...	·1	1
26. *Actea spicata* ...	...	·1	1
27. *Clematis montana*	...	·1	1
28. *Podophyllum emodi**	...	·1	1

(*ii*) Shrubs.—

29. *Rubus niveus* ...	...	·5	3
30. *Salix elegans* ...	...	·2	2
31. *Rosa macrophylla*	...	·2	2
32. *Acer acuminatum*	...	·2	2
33. *Lonicera angustifolia*	...	·2	2
34. *Berberis (zabeliana ?)*	...	·1	2
35. *Sprirœa (canescens ?)*	...	·2	1
36. *Viburnum fœtens*	...	·1	1
37. *Euonymus lacerus*	...	·1	1

* These species had scarcely sent their annual shoots above ground and were specially difficult to observe in consequence.

		Frequency.	Constancy.
(*iii*) Trees (seedlings).—			
38. *Picea smithiana*†	...	·4	5
39. *Pinus excelsa*† ...	...	·1	3
40. *Populus ciliata* ...	...	·1	1
41. *Taxus baccata* ...	...	·1	1
42. *Prunus padus* ...	...	·1	1

I have regarded a society composed of all or most of the first ten species as indicative of a soil favourable to the natural regeneration of silver fir under the general conditions existing in this compartment. Other species could probably have been added if observations had been more extensive and had covered different seasons of the year. It should be noted that, although *Indigofera gerardiana* is definitely favourable to natural regeneration in moderate quantities, it is equally definitely inimical to natural regeneration where it occurs in dense patches. Here I presume the light factor becomes critical. This applies to all similar gregarious shrubs, whether favourable indicators or otherwise in open formation, as for instance *Salix elegans*, *Rubus niveus*, and (in deodar forest) *Desmodium tiliæfolium*. The effect of repeatedly cutting back these shrubs has doubtless been most beneficial in obtaining regeneration.

I think it will be admitted that the almost uniform 2 inches average depth of humus in these plots is very striking, though the fact can only be fully appreciated when these plots are compared with adjoining ground in the same compartment where regeneration has failed to appear. Time did not permit me to make more than a brief examination outside the selected plots. I did, however, test the depth of humus in several patches of *Mertensia*, *Adiantum*, *Trillium* and *Oxalis acetosella* and I found that in such societies the depth averaged 6 inches and varied from 3 to 9 inches. These societies in which I found, as a rule, little or no regeneration of silver fir seem to indicate unsatisfactory soil conditions. They are sometimes associated with *Senecio rufinervis*, *Anaphalis cinnamomea* and *Rubus niveus*, and are frequently

† The observations for these species were only recorded on 4 out of the 10 sample areas.

2

found in well shaded spots. The total and complete absence of *Pteridium aquilinum* from the selected plots is worthy of more than passing note, especially as it was not uncommon in some parts of the area. Bracken is generally regarded in Europe as an indicator of a good forest soil. In the Parbatti Valley it also seems to be an indicator of a good soil and one suitable for the growth of high quality forest; but such soils are not in my opinion in the best condition for natural regeneration of silver fir, blue pine or deodar, though it is true that natural regeneration will sometimes appear where bracken is growing. In one or two localities I found the depth of humus associated with bracken to be about 8 inches. Parts of Kasol Compartment 1 and Bindraban Compartment 1, where natural regeneration of deodar had failed to appear, have been successfully regenerated by artificially planting deodar. In this operation the humus layer was broken through, and in both the areas mentioned bracken was present abundantly.

If we admit that a depth not exceeding 2 inches of humus is an optimum for silver fir regeneration and that such conditions can be associated with the presence of certain species, we have still to discover what injurious factor is associated with a deeper humus. Troup (1.—page 1138) mentions the possibility of an excess of carbon dioxide. I have already commented on the possible absence of nitrification. A much more vigorous and dense herbaceous undergrowth is also associated with a deep humus, and this undoubtedly reduces the available light both during the summer and in early spring when the thick mat of dead vegetation is first released from the pressure of winter snow and remains as a cover to the seedlings. Theorising in this direction is not, however, likely to further our knowledge, and careful experiments are required.

It is not proposed to discuss at length the action which may be necessary to reduce the humus where it is excessive. A drastic opening out of the canopy would produce this result in time, but in the meanwhile weeds would choke the ground and, as stated by Parnell (4), the humus would dry out at certain seasons of the

year causing the death of small seedlings. The alternative is to remove the humus artificially, say in strips 4 feet wide following the contour and cut right down to the mineral soil. Parnell and Deans (4) consider the cost of removing the humus hardly practicable or justifiable on a large scale. That this cost must be faced if any system of concentrated regeneration is to be continued seems inevitable. The excellent regeneration to be seen along the edges of paths in Kalga, and referred to by many writers as existing elsewhere bears eloquent testimony to the results which ought to be obtainable by this method. But it cannot be emphasised too strongly that the humus must be completely removed.

Before concluding this article I wish to give some results obtained in deodar forest which show rather forcibly the analogy between deodar and silver fir regarding the optimum depth of humus required to produce ideal conditions for natural regeneration. Ten plots were selected on exactly the same lines as for silver fir, at elevations varying between 5,500′ and 6,500′. The aspects varied from north-east to north-west. The sub-soil was in every case mica schist. The gradients varied from moderate to steep. The forests were in various stages of regeneration under the shelterwood compartment system. Four plots were taken in Rajthathi Compartment 1, three in Bindraban Compartment 1, and three in Kailiban Compartment 1. The average depth of humus (excluding Bindraban where this observation was omitted) was ¾ inch and varied between the extreme limits of ½ and 1 inch. This small variation is, I think, rather remarkable, even allowing for the admittedly inadequate number of observations.

The following is the list of species seen :—

A. Characteristic Species.

	Frequency.	Constancy.
1. Grass	4·9	(5)
2. *Galium asperifolium* ...	3·9	5
3. *Salvia glutinosa*	2·6	5
4. *Fragaria indica*	2·2	5

		Frequency.	Constancy.
5. *Viola canescens*	... ...	1·8	5
6. Moss ...	... ...	1·5	4
7. *Fragaria vesca*	... ...	1·9	3
8. *Indigofera heterantha*	...	1·4	3
9. *Desmodium tiliæfolium*	...	1·3	3
10. *Oxalis corniculata*	... ...	1·0	3

B. Species Not Characteristic.

(*i*) Herbs.—

11. *Thalictrum* sp.	... ...	1·1	3
12. *Saussurea candicans*	...	·9	3
13. *Agrimonia eupatorium*	...	·5	3
14. *Iris milesii*	... ...	·6	2
15. *Ainsliæa aptera*	... ...	·6	2
16. *Smilax parvifolia*	... ...	·4	2
17. *Taraxacum officinale*	...	·3	2
18. *Bupleurum* sp.	... ...	·5	1
19. *Adiantum* (*venustum ?*)	...	·4	1
20. *Desmodium podocarpum*	...	·3	1
21. *Valeriana wallichii*	...	·2	1
22. *Ranunculus* (*laetus ?*)	...	·1	1
23. *Androsace rotundifolia*	...	·1	1

(*ii*) Shrubs.—

24. *Berberis lycium*	... ...	·4	3
25. *Plectranthus rugosus*	...	·9	2
26. *Cotoneaster bacillaris*	...	·1	1
27. *Sageretia theezans*	...	·1	1
28. *Indigofera gerardiana*	...	·3	1
29. *Artemesia vulgaris*	... ...	·1	1
30. *Rubus lasiocarpus*	... ...	·1	1
31. *Rosa moschata*	... ...	·1	1
32. *Lonicera quinquelocularis*	...	·1	1

(*iii*) Trees (seedlings).—

33. *Pyrus pashia*	... ...	·1	2
34. *Picea smithiana*	... ...	·1	1

Though grass is shown as generally very abundant, it rarely formed an uninterrupted covering to the ground and where this did occur, as for instance in Bindraban Compartment 1, deodar regeneration several years old was observed to be dying. The reason for this is probably the obstruction which matted grass roots offer to the development of the deodar root system, and possibly grass in excess may also produce some unfavourable toxin.

In conclusion I wish to thank the Divisional Forest Officer, Mr. N. G. Pring, and the Range Officer, Sardar Puran Singh, for providing me with the history of the forests visited and for kindly collecting some specimens of unidentified plants.

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TREWIA NUDIFLORA (GUTEL)—TIME OF SEED COLLECTION.

BY M. D. CHATURVEDI, I.F.S.

1. The seed is obtained from the fruits by rotting their pulp. A fruit contains 3—5 seeds which weigh 160 to an ounce. The plant per cent. obtained at the Forest Research Institute, Dehra Dun, is 35. According to Mr. H. G. Champion the fruit ripens in November and December. The seed if dried can be successfully stored in good condition for sowings till the following March or even June. In his 'Silviculture of Indian Trees' Professor Troup has stated that the *gutel* seed ripens in July and keeps badly. In the North Kheri Division the fruit has been observed to fall from trees in large quantities in September-October. In the Gorakhpur Division the seed is actually collected in October. Such widely divergent views are held with regard to the time of seed collection of this species that it has been sought to ascertain the true position by comparing the plant per cent. of seeds collected at different periods.

2. The following samples were tested at the Silvicultural Garden, Clutterbuckgunj :—

500 SEEDS SOWN 6 INCHES APART.

Particulars.

Seed collected in	Time of collection.	Date of sowing.	1st germination.	Germination over.	Plant per cent.	On.
1. Gorakhpur (*a*)	October 1929.	Novr. 6, 1929.	Feby. 3, 1930.	May 31, 1930.	84·2	June 10, 1930.
2. Dehra Dun (*b*)	December 1929.	April 15, 1930.	April 30, 1930.	June 6, 1930.	54·2	June 10, 1930.
3. Do. (*c*)	Do.	June 25, 1930.	July 5, 1930.	August 2, 1930.	46	Aug. 15, 1930.
4. Do. (*d*)	July 1930	August 1, 1930.	Septr. 15, 1930.	Novr. 15, 1930.	20·2	Novr. 15, 1930.
5. Haldwani (*e*)	Do.	Feby. 2, 1931.	March 18, 1931.	June 8, 1931.	3·2	June 20, 1931.

NOTES.

(*a*) The seed instead of being stored was sown in a bed immediately after it was received.

(*b*) The seed was collected in December 1929 and stored at Dehra Dun till April 1930. Received at Clutterbuckgunj in the 2nd week of April.

(*c*) The *b*-sample was stored again till June at Clutterbuckgunj.

(*d*) Fruits with pulp were sown.

(*e*) Seeds (not fruit) were sown.

3. The seed collected in October and sown immediately afterwards in beds gives the highest plant per cent. It seems to be the best method of raising the seedlings of this species. Fruits collected in July were unripe and gave very poor results. The *gutel* is usually leafless from January to March. It sends out new leaves in April, and flowers in March and April. Fruits appear in July but are not ripe till September-October. They should be collected in September-October and sown immediately afterwards in nurseries.

4. Spring sown seeds give transplants at the break of rains and cuttings by the beginning of the 2nd monsoon.

AN EXPERIMENT IN THE IMPROVEMENT OF FOREST GRASSLAND.

BY W. BURNS, D.SC. (EDIN.), ECONOMIC BOTANIST TO THE GOVERNMENT OF BOMBAY AND PRINCIPAL, COLLEGE OF AGRICULTURE, POONA

The improvement of grasslands in the Bombay Deccan has engaged the attention of the writer for several years. The first* systematic attempts to study the behaviour of the poorer grasslands was made on a seven-acre block at Kalas, near Poona, from 1921 to 1930. The results obtained were so interesting and

* This work was largely financed by the Sassoon David Trust, which has made large benefactions in the cause of agricultural research.

promising that the collaboration of the Forest Department was sought and that Department kindly allowed the use of a 40-acre area at Bhamburda near Poona. This Bhamburda experiment was started in 1926, and has therefore been going on for five years. The nature of the experiment and the effects up to date on the vegetation will, it is believed, be of interest to forest officers.

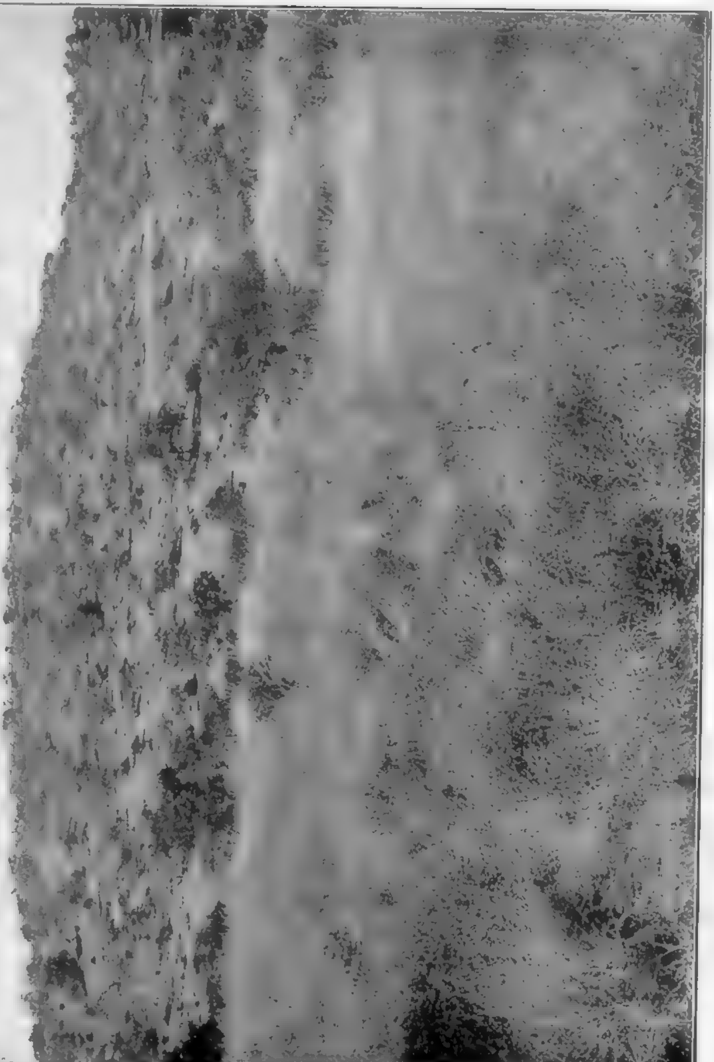
Plate 31 is a photograph of part of the area. It is on the lower slopes of a ridge of trap hills from 120 to 250 feet above the general level of the surrounding country. The altitude of the surrounding country above sea level is about 1,850 feet. The annual rainfall is about 25 inches. The upper steeper parts of the ridge show much exposed rock. The lower slopes are covered with soil which has largely come from the upper slopes, which soil is always in danger of being still further drifted downwards by the early rains. The soil types vary from mere gravel on the top of rock to deep medium-black soil which may be up to 5 ft. deep. Such deep black soil is eroded in some places into formidable nullas.

The Divisional Forest Officer, Working Plans, Central Circle, Bombay Presidency, states:—

"The area was afforested in 1879. There is no record of any working for exploitation of tree growth prior to the introduction of Working Plans and since such introduction it had been classified as Pasture and been open to grazing of unlimited numbers of cattle on payment of fees. Some spasmodic plantation work limited to teak or sandal may have been attempted from time to time, but no record of any such work exists, nor can any great success have been obtained judging from a scrutiny of the existing stock."

The dominant tree at present is *Boswellia serrata*, and there are scattered specimens of the following species:—

Acacia leucophlœa, *Bauhinia tomentosa*, *Rhus mysorensis*, *Odina wodier*, *Flacourtia ramontchi*, *Cochlospermum gossypium*, *Anogeissus latifolia*, *Terminalia tomentosa*, *Gymnosporia montana*, *Zizyphus jujuba*, *Zizyphus aenoplia*, *Zizyphus xylopyra*, *Azadirachta*



Bhamburda grazing area showing the hill slopes and low plains with vegetation.

(*Reproduced from Botanical Memoir, Deptt. of Agriculture in India, Vol. XVI, No. 4, by kind permission of the Government of India, Department of Industries and Labour.*)

indica, *Santalum album*, *Osyris arborea*, *Tectona grandis*, *Heterophragma roxburghii*, *Stereospermum chelonoides*, *Dolichandrone falcata*.

The general ecological type of the vegetation is thorn-forest,* with the trees sufficiently widely spaced to permit of a vigorous growth of grass between them, and it is the grass which is the material of value. Like other similar places this area is sold for grazing, and the experiment now described was a first attempt to apply (though on a small scale) certain ideas and principles partly gained by previous work at Kalas and partly gleaned from the publications of workers on similar lands in America.

The main items in the improvement programme were :—

(1) Very simple land development by making low contour embankments with the scattered stones of the area, in order to check surface (*i.e.*, sheet) erosion, especially at the break of the rains.

(2) Rotational grazing with a limited number of cattle.

The area had already an external fence, and it was divided by internal fences into four blocks of ten acres each. The number of animals used at the beginning of the experiment was at the rate of one animal to 2½ acres in 1926, *i.e.*, 16 animals. These were at the beginning of the experiment distributed to

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* Mr. E. A. Garland, D.F.O., Working Plans, Central Circle, Bombay Presidency, however, wrote to the author as follows :—

"As regards the general ecological type of vegetation, my personal opinion is that it represents a regressive subsere of mixed deciduous forest rather than thorn-forest. Reduction of the closed canopy of mixed deciduous trees by uncontrolled exploitation prior to the introduction of forest conservancy exposed the soil to erosion. The humus has been greatly reduced and both this reduction and actual erosion of the soil have been accelerated by a high incidence of grazing. The climatic conditions verging closely on those of a tension belt between mixed deciduous and thorn-forest, the more xerophytic conditions which have been thus introduced have favoured the invasion of thorn species and the mixed deciduous species have been reduced to stunted growth and a very open crop. Grasses which would naturally be present in a partially suppressed state under the closed tree canopy have spread extensively. But the vegetation i unstable as is shown by the changes which have occurred in the short time your experiment has been modifying the site factors."

all the plots, and the original plan of the experiment was as follows:—

Block I.—To be grazed all the year round.

Block II.—To be closed *biennially* till the young grass had made its growth (*i.e.*, till the middle of August) and grazed thereafter.

Block III.—To be closed *annually* till the young grass had made its growth (*i.e.*, till the middle of August) and grazed thereafter.

Block IV.—To be cut for hay annually and grazed thereafter.

In 1928 the plan was altered as the result of our experience of the grazing habits of the animals, and as the four blocks were not strictly comparable, and the whole of the animals were grazed in one herd and moved from block to block keeping one block for cutting after seeding (with grazing afterwards). In 1929 the number of animals grazed was 30 and in 1930 the number was 20, this being apparently the most suitable number for the area (*i.e.*, one per two acres of the total amount of ground).

A bore was sunk in one of the blocks and drinking water was available for the cattle. Rock salt was also used according to American practice. A chunk of this was put in a wooden box here and there in the grazing area and the amount of salt used by one animal during the season was about 11 oz. a month from November to February. The salt was not given in the rains partly because it would have been dissolved by the rain and partly because it was used as a means of attracting the cattle to the less palatable grasses still remaining to be eaten. The cattle got very fond of the salt and would stay beside it and even queue up for a lick at it. The salt probably induced the drinking of more water and this may also have had some effect on the utilisation of the less palatable grasses and the later dried vegetation.

Observations were made at frequent intervals partly on the vegetation as a whole, partly on three metre-quadrats laid out in each block, and in the year 1930 (to be done also in 1931) two acres per block were set aside and fenced against the animals,

to be cut whenever the animals were changed from one block to another in order to get some idea of the feed that the animals were actually removing from any particular block.

The main results are as follows :—

Block I.—This consists mostly of deep black soil and carried good perennial grasses such as *Andropogon annulatus* and *Andropogon monticola*, and also useful annual grasses such as *Panicum isachne* and *Iseilema anthophoroides.* The constant grazing and trampling to which this block was subjected (all the year round grazing during the first two years) rapidly reduced the population of the good grasses mentioned above, with consequent invasion of the spear-grasses *Andropogon contortus* and *Aristida* species. In badly overgrazed patches in black soil, where good palatable grasses had sustained an undue amount of concentrated grazing, the spiny weeds *Echinops echinatus* and *Lepidagathis cristata* also appeared. This block was in the space of two years a very definite warning as to the deterioration that sets in as soon as continuous and excessive grazing is allowed. To permit of recovery and to get further data this block was closed in 1928 until the seeds had dropped, the grass then cut, and cattle allowed to graze after cutting. In 1929, however, since the grass in Block Nos. II and IV was insufficient, Block I was again opened to grazing instead of reserving it for cutting. In 1930 the block was closed to grazing till after the seeds had dropped and the grass been cut. Good late rains in 1929 helped Block I greatly but the main point to notice is (see table) that *continuous* grazing with a small number of cattle is far more damaging to vegetation than grazing for shorter *discontinuous* periods with a *large* number of cattle. This is the argument for rotational grazing. These three years have permitted of the recovery of the area, indicated by the increasing yields given on cutting and the disappearance of the invading poor grasses and weeds.

Block II.—This is of poorer soil and the characteristic grasses are the annual form of *Andropogon contortus* and *Aristida* species (on the more level areas) while on the more sloping areas are found *Andropogon monticola*, and *Ischæmum laxum* (both

perennials). The continuous grazing on this block from August 1926 to February 1928 resulted in the perennial grasses suffering severely, and the relative increase of the less useful annuals. Since 1928 (in the changed experiment) Block II has been subject to rotational grazing amounting to anything from three days to a month and a half at a time, depending on the amount of grass available. Grazing on this area has, as far as possible, been confined to the later part of the season so that the annual grasses may get a better hold and also have time to seed. There has been a definite improvement in the grass especially in the annuals.

Block III.—This has medium black soil rather like Block I, with corresponding grasses but not much *Andropogon annulatus.* In this block the animals were at first not allowed till August 15th. The result was that the perennial grasses had made much of their growth and developed hard stems. The cattle ate the tender tops and allowed the harder lower parts to remain. These hard stumps interfered with later growth and also the growth of the following season. In the changed plan we admitted cattle to this block from the beginning of July onwards at different times according to the rotational scheme. With Block I being closed until cutting, this block was open for grazing for a longer total of time than either Blocks II or IV as it was necessary to graze it early and at intervals to keep down the coarse growth.

Block IV.—This block was closed till after seeding for the first two years with a little grazing after cutting. This closure resulted in an enormous improvement of the grass in quality and quantity. The soil and vegetation here are like those of Block II, with a patch of better soil at the border of Block III. This Block IV has also been open to rotational grazing after the first two years.

The following table will show the actual grazing and cutting done. The word "unit" means one animal grazing for one day :—

Table showing the actual grazing *and* cutting *done at* Bhamburda Grazing Area.

Year.	Block I.	Block II.	Block III.	Block IV.
1926 ..	*Grazed.* Days 156 98 51 Animals 4 5 4 Units 624 490 204 Total units—1318	*Grazed.* Days 172 109 65 2 Animals 5 3 2 1 Units 860 727 130 2 Total units—1319	*Grazed.* Days 192 25 Animals 4 2 Units 768 50 Total units—818	*Harvested.* Yield 1,053 lbs. per acre. No second growth hence no grazing.
1927 ...	*Grazed.* Days 270 Animals 5 Total units—1350	*Grazed.* Days 244 Animals 5 Total units—1220	*Grazed.* Days 199 Animals 5 Total units—995	*Harvested.* Yield 2,050 lbs. per acre. No second growth hence no grazing.
1928 .	Harvested and then grazed Yield 3,300 lbs. per acre. Days 35 Animal 17 Total units—595	*Grazed.* Days 4 49 30 Animals 17 17 16 Units 68 833 480 Total units—1381	*Grazed.* Days 15 17 40 Animals 16 17 17 Units 240 289 680 Total units—1209	*Grazed.* Days 28 40 Animals 15 15 Units 420 600 Total units—1020
1929 ...	*Grazed.* Days 47 38 Animals 31 31 Units 1457 1178 Total units—2635	*Grazed.* Days 22 2 Animals 29 29 Units 638 58 Total units—696	*Grazed.* Days 19 20 53 3 Animals 31 30 30 30 Units 589 600 1590 90 Total units—2869	*Grazed.* Days 26 23 Animals 27 27 Units 702 621 Total units—1323
1930 ...	Harvested and then grazed Yield 3,700 lbs. per acre. Days 26 9 3 Animals 20 19 19 Units 520 171 57 Total units—748	*Grazed*.* Days 21 24 Animals 20 20 Units 441 480 Total units—921	*Grazed*.* Days 15 25 18 7 4 Animals 19 21 20 20 1[illegible] Units 285 525 360 140 76 Total units—1386	*Grazed.** Days 19 31 18 4 Animals 21 19 20 19 Units 399 589 360 76 Total units—1424

* In Blocks II, III and IV only 8 acres (instead of 10) were available for grazing in 1930, the other 2 acres per block being cut each time cattle were put into the block so as to get some idea of the amount of seed consumed.

The general drift of the experiment is towards a greater carrying capacity, taking the area as a whole. The irregularity of the periods spent by the cattle in any one block is due to differences in season making the grass more or less easily exhausted.

At present we are able to keep a herd of 20 cattle in good health (as shown by their weights and general condition) on the grazing alone from July till December. They can still be maintained on grazing only during January and February, though they lose in weight but are not otherwise unhealthy. In the period March to June inclusive they are allowed to roam about a little in the morning, picking up what they can get, but have to be stall-fed with the hay and silage made from one of the blocks, no other food being given. The area is, therefore, capable of maintaining *all the year round one animal per two acres.*

We have observed that where grass is plentiful neither the trees nor the tree seedlings are attacked by the cattle.

Admitting that this experiment is on a very small scale, and that it has been done in a manner not possible of exact imitation in practice, certain basic principles seem to emerge, and will probably be clearer after the present season's observations are available, namely :—

(1) The best way to make the full use of grassland is to take advantage of the gregarious habit of cattle and graze a large herd in one restricted place rather than allow them to wander at will over a big area. Where fencing is impossible such restriction will have to be done by herdsmen.

(2) For such lands as we have described one animal to two acres seems about right. This means one animal to the total area within the rotation system. The actual density in the block occupied by the cattle will of course be this multiplied by the number of blocks used.

(3) In practice the blocks will obviously have to be large, *i.e.*, hundreds instead of tens of acres.

(4) In practice the length of time that any block shall be grazed will have to be arbitrarily fixed. This period will have to be determined by experience. One can only say that in the first instance it will probably be wise to err on the side of too short rather than too long an occupation of the ground.

NOTE ON THE UTILIZATION OF SLASH WOOD AFTER EXPLOITATION IN CHIL FORESTS IN LOWER MURREE RANGE, 1920-21.

BY RAM NATH KASHYAP, P.F.S.

In consequence of regeneration fellings carried out in Sambli R.F. C.83 i and C. 84, so much refuse wood was left over the area that it was considered most essential to dispose of it. The sale of firewood from this locality was out of the question, and it was, therefore, decided to convert this refuse wood into charcoal and export it to Rawalpindi for sale. The work was started in October 1920 and closed in the last week of March 1921.

2. *Labour employed on burning charcoal.*—The maximum number of coolies employed on this work was 80, 50 being the average, half the number being from Charihan, Parina and Bagla villages of Upper Murree Range and the other half from Sambli, Anguri, Chakka and Manga villages of Lower Murree Range.

3. *Labour for carriage of charcoal.*—It was a difficult problem to carry the charcoal from the forest to the cart road (a distance of about 12 miles) on account of the large quantity of timber which had also to be carried simultaneously. Camels are not easy to obtain in this locality and hence bullock transport is the chief means of extraction, but the number of bullocks available locally was not sufficient to cope with the work. About 100 bullocks were, therefore, obtained from Upper Murree Range. On account of the scarcity of fodder, special arrangements for fodder and gram for these imported animals had to be made from Rawalpindi and the cost of such fodder, etc., was borne by the owners,

i.e., it was only a matter of arranging things with no extra cost to the Department.

4. *Working rates.*—(*a*) Labour for burning was paid for at the rate of Rs. 0-7-0 per maund by the mates, who in turn were paid by the department Rs. 0-9-0 a maund for the charcoal burnt and packed in sacks supplied by the purchaser. To keep a control over the payment of proper wages to the burners (*i.e.*, Rs. 0-7-0 a maund) a small gang was paid departmentally and no commission was paid to the mates. Under such arrangement 750 maunds of charcoal were burnt.

(*b*) The rates paid for carriage were as follows :—

	Rs.	a.	p.	
From C.83 i and C.84 to cart road by bullocks	0	8	0	a maund.
From cart road to Rawalpindi by carts	0	5	0	„

Upper Murree bullocks were paid by their mates at Rs. 0-7-0 a maund whereas the local bullocks got Rs. 0-6-0 a maund from the mates.

The Upper Murree bullocks worked for about 2 months. After the close of March accounts I did away with the mates and found it more convenient to pay Rs. 0-6-0 a maund direct to bullock men daily at "22 mile" Depôt on cart road. I strongly recommend that at least local transport should invariably be employed and paid direct without engaging a middleman. It keeps the labour contented and keeps the cost low.

5. *Estimated volume of timber consumed and quantity of charcoal obtained.*—An experimental kiln was burnt with wood measured and weighed. 550 c.ft. stacked of green wood cut out of poles weighing $298\frac{3}{4}$ maunds was burnt into 44 maunds of charcoal. This means 100 c.ft. stacked yielded 8 maunds of charcoal. In all 7,710 maunds of charcoal were burnt, *i.e.*, 96,375 c.ft. stacked or 64,250 c.ft. solid of wood were consumed in this conversion.

6. *Financial aspect of the experiment.*—

	Rs.	a	p.	Mds.	srs.	ch.
Total quantity of charcoal burnt	...			7,710	0	0
Total cost of burning 7,710 maunds and carrying 7,414 maunds to Rawalpindi as detailed in the statement enclosed ...	10,984	8	0			
Revenue by sale of 4,789 maunds	15,590	8	0			
Anticipated revenue from 1,875 maunds to be sold ..	5,625	0	0			
	21,215	8	0			
Net profit	10,231	0	0			

or Re. 1-5-0 per maund on the quantity burnt or Re. 1-8-6 on the quantity sold—6,664 maunds. In addition to the profit in cash, 296 maunds of charcoal was handed over to Range Officer, Resin, for departmental use.

7. *Loss in transit.*—The following weighments were made to check loss in transit:—

No. of sacks of charcoal.	Forest weight	Rawalpindi weight.	Loss in transit. Total.	Loss in transit. Per maund on quantity despatched.
	Mds.	Mds.	Mds.	
280	220¼	208¾	11½	2 seers
376	283	254¼	29	4 ,,
3,146	2,214	1,875	339	6 ,,

Average loss per maund of charcoal despatched from forest to Rawalpindi—5·5 seers.

On 4,380 maunds sold to L. Sundar Das an allowance of 2 seers a maund was allowed and this loss amounted to 224 maunds. Thus in all about 604 maunds were lost as dryage and dust in transit out of (7,710—296) = 7,414 maunds or 8 per cent.

Further it was determined that 75 per cent. of this loss occurred in journey from the forest to 22 mile *i.e.*, during pack-animal traffic and only 25 per cent. on the cart road.

8. *Miscellaneous*—(*a*) Charcoal in the forest should be weighed at least 2 days after it has been packed in sacks.

(*b*) On an average about 40 canisters of water are required to extinguish charcoal burnt in one kiln.

(*c*) Charcoal obtained from dry wood is superior to that obtained from green wood.

Abstract of expenditure incurred on burning charcoal at Sambli.

No.	Particulars.	No. or quantity.	Amount. Rs. a. p	Remarks.
1	Carriage of empty sacks from Ghora Gali and 22 mile to Sambli	12,054	107 1 9	
2	String (sutli) for packing charcoal sacks.	$1\frac{1}{2}$ mds.	37 13 2	
3	Construction of sheds for storing charcoal in the forest C.83 i and C.84 ...	5	59 8 0	
4	Burning charcoal @ 9 annas a md. the contract rate, including 50 maunds burnt on daily labour at a cost of Rs. 54	7,710 mds.	4,256 1 11	
5	Carriage of charcoal from kilns to sheds @ 6 pies per sack ...	4,538 ,,	141 3 0	
6	Supplying water for charcoal burning in two places only, half cost borne by contractor	18 kilns	11 4 0	
7	Carriage of charcoal from forest to "22 mile" Depôt	$6,018\frac{3}{4}$ mds.	2,962 0 6	
8	Carriage of charcoal from forest "22 mile" depôt to Rawalpindi	5,066 ,,	1,649 11 0	
9	Miscellaneous—as repairing water springs, etc.	...	28 15 0	
10	Carriage of charcoal from forest to "22 mile" depôt	1,132 mds.	424 8 0	as. 6 a md.
11	From "22 mile" depôt to Rawalpindi	2,217 ,,	692 13 0	as. 5 ,,
12	Depreciation on sacks purchased from S & T @ Rs. 30-10-8 per cent @ 50 per cent	400 sacks	613 5 4	
	Total cost on burning 7,710 mds. and carrying 7,414 mds. to Rawalpindi ...	...	10,984 4 8	

REVENUE FROM SALE OF CHARCOAL.

	Rs.	a	p.
Sold to L. Sunder Dass—4,380 mds.. @ Rs 3-4-0 a md. ...	14,235	15	6
Sold to a Gujranwala firm, 300 sacks—200 mds. ...	650	0	0
Sold by auction at Rawalpindi, 280 sacks, 208 mds. 30 srs. at Rs. 3-6-0 per md.	704	8	6
To be sold 1,875 mds. @ Rs. 3 a md.	5,625	0	0
Total sold 6,653½ maunds for	21,215	8	0
Net profit ...	10,231	0	0

NOTE.—296 maunds charcoal were supplied for resin work.

WHEN WILD LIFE AWAKENS IN KASHMIR.

BY SHER SINGH, D.F.O., RAMBAN.

Kashmir is a land of lakes, lilies and snow-clad hills, but above all it is an enchanted arena of contrasting colour effects. Nowhere else on the face of earth are the colours of nature more gorgeously arrayed than in this Happy Valley, and at certain times of the year, all the rainbow colours can be seen side by side. The wild grandeur of the forested mountains, of secluded glens and glistening snows, has inspired many a poet, such as Moore and Shelley, but only a Wordsworth can do full justice to the true inwardness of Kashmir beauty. These polychromatic effects are seen at their best in March and April when life just awakens from the lap of Morpheus. At that time of the year, the snow melts from the ground and the forest floor, and the invigorating rays of the sun send a fresh impulse of life into the veins of the vegetable world. Each day registers higher pulsation of the heart-beat, and decreasing hold of ground by the retreating snow, until one fine morning the whole valley is one vast blaze of colour!

This arrival of spring in Kashmir is heralded by the almond groves, which are the first to burst into blossom. The foot of the hills adjoining Srinagar (Kashmir) are studded with fruit gardens, and the sudden simultaneous blossoming of these groves is a rare sight to see. The delicate pink of the blossoms resembles sun-lit clouds more than anything earthly, and even as that coppery sheen

bespeaks of the coming sun, so do the almond blossoms usher in the emerald verdure of the early summer. Then comes the brilliant pink of peach blossom, the rose-white of apricot, the pearly whites of the plum and the pear, and the different shades of pink and white displayed by the apple, the fruit tree *par excellence* of Kashmir. The almond, the apricot and the peach flower before putting on their leaves, and their rich gala dress is an unusually pleasing sight. Particularly is this true of the apricot which, though one of the commonest fruit trees of the hill villages, occurs scattered, usually in a matrix of *chir* or other pines, when its pink is relieved by the evergreen conifers. As may be expected, the air at the time is resonant with the sweet humming of the busy bees which frisk and flirt, cross-fertilising this, that and indeed, every flower, as they go in search of honey. The flowers and the bees are bosom-friends. Without the helping agency of the bees, there would be no fruits in our orchards. The forest trees are, of course, different as they are contented with the agency of wind alone, which is also helpful to fruit trees. The surrounding atmosphere is fragrant with the sweet scent of budding blossoms, prominent among which is the cultivated willow of Kashmir (*bed mushak, Salix caprea*) the flowers of which are distilled for medicinal purposes. This spring scenery in Kashmir is set off by lakes and running streams, on the one hand, and by rugged sun-lit cliffs, on the other, which cast soft violet and deep purple shadows in the opalescent waters below.

The season of spring blossoms is a national festival for the Kashmiri Pandits who pour out of the city in thousands on the fine days of March. They take with them their cooking pots and tea-kettles and remain in the gardens the whole day long holidaying in right royal fashion, for which observance there is no close parallel in India. In Japan, however, there is a corresponding practice, the national custom of *Nagami* or Beholding the Flowers. The Kashmiris go even further than the Japanese in their love for nature and observe as many as three *Nagamis*; first in the foothills of Hari-Parbat and Gupkar early in March, when the almonds are just in blossom, secondly in April and May when the roses are in bloom, and lastly in July

when the lordly lotus rears its head above the waters of the Dal and displays its ruby-red petals to the dancing rays of the sun. The latter two festivals are invariably held in the Nishat and Shalimar Gardens of the Mughals, which are unsurpassed for their majestic beauty and rich grandeur. These gardens are the only relics of Mughal rule in Kashmir, but no one, who has seen them, can deny to the Mughals unstinted praise for their unbounded love of Nature, and breadth of vision. The Mughals were great builders and rulers, but their gardens have outlived their great empire. The cascades and the terraces which they laid, the marble pavilions and many-fountained tanks which they constructed are as fresh to-day as at the time of construction, and they will live for ages to come as memorable mementos of the munificent Mughals. In these sequestered enchanted gardens, the Mughal Emperors used to lull their ruffled minds disturbed by the thousand and one worries of State. Jehangir considered them to be heaven itself on earth, and although opinions will differ about this, there is no gainsaying the fact that they have a mysterious tranquillising effect on every mind. If spring were not as mutable and transient as it unfortunately is, one could well pass the days of one's life in these gardens under the stately chenars and poplars, and by the purple iris so that "one day should be like another, one life the echo of another life." But spring is fleeting like the sands of time and we cannot stay its march.

The Jammu hills surrounding the Valley do not display the gorgeous colouring which is characteristic of Kashmir, but even here there is a sharp difference in colour in spring, and there are few more splendid sights to be seen than that presented, for instance, by broad fields of golden-yellow *sesame*, contrasted with the mauve and pink of poppy which is cultivated all along the upper reaches of the Chenab, the rich emerald of the wheat, and the deep azure of the sky. More prominent, if subtle, is the brick-red sheen of grass on the sun-lit slopes in the background, which is still crisp due to autumn. The northern slopes on the opposite side display many patches of deep rich and orange red, characteristic of many deciduous plants on the recovery of their foliage. Among these copper-coloured plants, *kakrai (P.*

integerrima) is worthy of special mention, as it produces the same weird effect in inner hills as the flame-red flowers of *dhak* (*Butea frondosa*) have on the outer hills of Jammu. These anthocyan colours are, however, soon succeeded by the usual green chlorophyll colour. The moist inner valleys of these ranges are very often ornamented with showy, deep-crimson flowers of *bras* (*Rhododendron arboreum*), while a blaze of red, yellow and white is afforded by the wild pomegranate, barberry, and white rose on the outer slopes. A strong aroma is wafted by the wind from the *garna* (*Carissa opaca*) which is, if anything, sweeter than the Jasmine, but this flower, as also its fragrant-twin the *ber* (*Zizyphus oxyphylla*) is far too begirt with thorns to be of much use. This spinescent vegetation is characteristic of the sunny Siwaliks, and possesses no particular spring charm.

Last but not least, it is the flowers on the hill tops and in the valleys which are very characteristic of spring and of which a brief mention is necessary. They are like pearls scattered in the green sward, and are real earnests of the flush of the coming new life. The earliest and most beautiful is the yellow-flowered saffron (*suranjan*, *Colchicum luteum*) which is very common in Kashmir, peeping out of snow even as early as February. It has a few radical leaves and a golden-yellow crocus-like flower, which is much in demand for its medicinal effect. It is followed in quick succession by the violet, the strawberry, dandelion, and the edible morels (*gachhis*) which find a ready sale at all times of the year in the Punjab. Accompanying, or even preceding the saffron, is the *basanti* flower (*Reinwardtia trigyna*) of the same colour and synchronous with the *sesame*, but it occurs at lower elevations. On the hill tops proper, the first flower to appear is the pale pigmy potentilla (*P. sibbaldi*) which is common above 9,000′ and is frequently met around hill-tarns like Sheshnag, etc. This is followed or accompanied by the aristocratic primulas such as *P. denticulata* with its cluster of basal leaves and showy lilac flowers, *Androsace rotundifolia*, so called because of its round eaves. Other early flowers are species of *Anemone* which are wind-fertilised, *Fritillaria imperialis*, a very showy lily, with its

pendulous cluster of orange flowers, so common in beds of nalas; the rock-splitter, *Saxifraga ligulata*, which flowers early in March, bearing bright pink one-sided panicles. In the forest, under the shade of deodar and fir, the first two to burst into blossom before even leaves are species of *Viburnum* (*V. foetens* and *nervosum*), and the Indian witch-hazel (*pohu*, *P. jacquemontiana*) with four large pale-yellow bracts resembling petals. The succession of colours and flowers *after* spring is, if anything, more rapid, because they have to cover their vegetative season in comparatively less time. Already in May, we see dandelion fruiting, surrounded by the wild thyme and the gentians, but this brings us well into summer which is beyond our present purview. One thing, however, is evident that the humble flowers are as busy and in earnest in proclaiming the advent of spring as are the *koel* and the cuckoo. They speak in colour what the blackbird utters in melodious notes!

It is hardly necessary to reiterate that spring is ever a welcome season in all countries and climes, for then nature ceases to hibernate and assumes once more the dynamic life which is its very essence. But nowhere is it more welcome or more at its best than in Kashmir, for here it is attired in its very best honeymoon dress. This is so because Kashmir sleeps a sound sleep in winter, and the deeper the burial in the bosom of winter, the more thrilling and transcendent the recoil of resurrection!

TYPES OF HUMUS LAYER IN THE FORESTS OF NORTH-EASTERN UNITED STATES.

By L. G. Romell and S. O. Heiberg. Ecology 12: 567—608, 1931.

The paper represents a first systematic effort of applying outside Europe the principles and method laid down by P. E. Muller in his classical studies on natural types of humus layer. It is also a contribution to the question of classification and nomenclature of forest humus layers in general. After a critical review of the different proposals of classification, the authors conclude that Muller's system fits the natural conditions best. That this holds true for American conditions as well is indicated especially by the flora characteristic of different types of humus layer. A fundamental point of Muller's system is that the classification applies to the entire humus layer (*i.e.*, the top layer of the soil, owing its characteristic features largely to its humus content; no matter whether this content is high or low and whether the humus is "incorporated" or not). The authors strongly oppose the tendency inaugurated by Ramann to classify the humus alone, which is only one constituent of the biological unit. Muller's two main types or groups are retained. They are characterized morphologically, as the Scandinavian school has always done, contrary to the tendencies in Germany, and some types with unincorporated humus are included in the mull group. Specific types listed are crumb mull, grain m., twin m., detritus m., root duff, leaf d., greasy d., and fibrous d. This list is not supposed to cover any variation possible, but is just an enumeration of conditions found to occur within the region studied sufficiently regularly and characteristically enough developed to warrant their being recognized as types. The crumb mull is the classical prototype of the mull group, inhabited by large earthworms. The types greasy and fibrous duff have been taken over from the Danish Forester, Juncker.

The distribution of the types within the region is discussed. Groundwater conditions seem to be a particularly important factor locally. Some plants are listed as indicators of mull and

of duff. The most valuable hardwood species of the region seem to be among the mull preferring plants.

Data are presented on nitrification, pH and lime content of the different types. Contrary to European experience, nitrification was found in the laboratory within all types, even pronounced duffs, and down to a pH of 2·9 which was close to the lowest pH value encountered in any sample, whether nitrifying or not. Still, a great difference was found between the types, the mull samples being practically all nitrifying, whereas the majority of samples of pronounced duffs did not nitrify. Storage tests yielded surprisingly high values for root duff and other intermediate forms, as compared to the crumb mull, while inoculation tests gave results agreeing better with the expectations from previous experience and with the indications furnished by the vegetation. The puzzling results of the storage tests are ascribed to a "sampling effect" to be discussed in a later paper.

The main data are given in concentrated table form on eight pages. A mimeographed Appendix of 29 pages, distributed by the authors, gives descriptions of 17 chosen localities including vegetation and soil notes, Bouyoucos analyses, etc.

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NOTICE.—Correspondents who wish their letters to appear in a particular number of the *Indian Forester* should ensure that they reach the Honorary Editor by the 15th of the previous month with a request to that effect.
